VARIABLE LEARNING ENVIRONMENTS

A Thesis
Presented to
The Academic Faculty

By

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In Partial Fulfillment
Of the Requirements for the Degree
Master of Architecture

Georgia Institute of Technology
May 2011

VARIABLE LEARNING ENVIRONMENTS

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PREFACE

This thesis contains two distinct but interrelated works: a research-based written document with design implications, and a design project, which takes into account the research findings.

It is important to note that although the research and written portion of this thesis has been an individual effort, the design project has been collaborative. Ian Reves, Emily Finau, and I have worked equally to weave individual research threads into the design. At the point of publication of this document, the design project is still undergoing final development. Therefore, the design as it is documented here should be viewed as indicative of intent and process and not as our final statement.

In Part 3 as well as in the Appendix of this document, the underlying design elements and ideas represented are the product of a collaborative effort, with individual drawings completed by Ian, Emily, or myself. Although the design ideas and drawings have been collaborative, we have each represented them in our written commentary through the lens of our individual research topics.

As a final note, while my research topic of place making and environmental effects on behavior is represented thoroughly in this document, Emily and Ian have comprehensively represented their own research topics of transparency and its effect on learning spaces, and modular fabrication techniques, respectively, in their own theses. A combination of these three inputs has resulted in a thorough and meticulous school design proposal.

ACKNOWLEDGEMENTS

I would like to thank my advisory committee for their knowledge, guidance, patience, and encouragement.

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SUMMARY

The environment affects the user both psychologically and physiologically. Teachers often alter their classrooms in order to effect these changes whether by adding elements for warmth, offsetting harsh lighting, or using found objects to mark and divide space. While teachers attempt to create variety post facto, it is important for designers to examine the research on environmental impact and post-occupancy evaluation, which communicates a need for the planned variety of spaces in function and in character.

This project begins with an investigation: discovering the research that examines the environment's impact on the user and understanding its relevance to students' perception of the environment and learning outcomes. The project terminates in the application of this research in a redesign of Therrell High School in southwest Atlanta. Therrell is divided into three thematically described small learning communities, which effectively function as three separate high schools: Therrell School of Science, Technology, Engineering, and Math, Therrell School of Health Sciences and Research, and Therrell School of Law, Government, and Public Policy.

The design project seeks to complement Atlanta Public School's movement to small learning communities by enriching the variety that this

program embeds in the public school system. It addresses the varied instructional strategies that accompany the thematic endeavors of each school, and also introduces variety in character, thus accommodating variable psychological and physiological needs and desires of students. The focus of the project will be on the student and the nature of space that fosters positive experiences as well as positive learning outcomes.

INTRODUCTION

1.1 PUBLIC HIGH SCHOOLS

The Atlanta Public Schools' brochure on the local "High School Transformation Initiative" refers to the nation's "High School Crisis." It cites a nearly one third dropout rate among all high school students in the nation and nearly one half among minority students (Atlanta Public Schools, 2008). Even worse is the cited statistic that a high school dropout is eight times more likely to be incarcerated than someone who finished high school (Atlanta Public Schools, 2008).

The Bill and Melinda Gates Foundation, which has actively worked to combat high dropout rates, commissioned a survey of U.S. students who dropped out of high school. The report "The Silent Epidemic: Perspectives of High School Dropouts," released in 2006, published the results of that study. The results highlight the fact that a student's decision to drop out "…is the end of a long-term process of disengagement" from school (Bridgeland, Dilulio, & Morrison, 2006, 11, 16). The survey found that the majority of students reported being frequently absent from school with less than half ever being contacted by anyone at the school regarding their absences (16, 18). The majority of students reported not knowing "…someone in school with whom to talk about personal problems"(21). The problem is more widespread than a matter of simple academics. The

study found that over two thirds of the students who dropped out were achieving C's or better in school, and even more reported feeling "…confident they could have met their school's graduation requirements"(11). These results are consistent with the reasons published in the APS brochure. Collectively, they boil down to a general disengagement with both curriculum and staff.

When Bill Gates spoke at the National Education Summit on High Schools (2005) he referenced the three new "R's" of education: rigor, relevance, and relationships (para. 46). Students need to be connected to their work, not simply lectured to, and they need to have positive relationships with adults who are concerned with their success (Gates, 2005).

Research supports this new framework. The OECD completed an assessment of U.S. student achievement compared to that in other nations. The results (see figure 1) showed that U.S. high school students are behind many other industrialized nations in math, science, and reading (Lemke & Gonzales, 2006) Further analysis of the results yielded the finding that students had particular difficulty applying their knowledge, in other words, it did not carry over to different circumstances (Lemke & Gonzales, 2006). This finding, combined with the high dropout rate, communicates simply that standard lecture delivery in standardized classroom environments is not enough to keep students engaged or to give them

fluent command of necessary skills.

Such students are not simply disengaged with their academic work. Research shows that learning outcomes are positively correlated with a sense of belonging at school as well as with positive relationships (Kileen, Evans, & Danko 2003; Laroque, 2008; Mitchell et al 2010; Liu & Wang 2008; Dubois 2010). Students perform better when they feel supported and encouraged by their teachers. Positive relationships with teachers and mentors are one way that academic work finds relevance in a student's life.

All of this research is behind the movement toward Small Learning Communities. Assessment of smaller schools has yielded positive results indicating decreases in disruptive behavior, increases in student attendance, and higher graduation rates (Gates, 2005; USDOE, 2011). The government recommends the move to smaller learning communities paired with 'complementary personalization strategies' and is providing extensive grants to fund the transitions. Atlanta Public Schools received just over $2.1 million in 2010 alone to help fund their continuing High School Transformation Initiative (USDOE, 2011).

Small learning communities are characterized by personalization and variety in the learning environments. Research supports the idea that students need to be in warm, welcoming environments; they need to be engaged in positive supportive relationships; and they need to feel a

sense of belonging at school in order to be most successful. The environment should reflect the individuality of the students as well as accommodate the variety of learning needs that accompany them. Addressing this, Small Learning Communities are described by the U.S. Department of Education as offering 'engaging instruction' chiefly characterized by varying methods and modalities of presentation, integration, and assessment of new skills. Teachers are encouraged to collaborate and observe one another, and to be continuously responsive to assessment when devising instructional methods. They are encouraged to personalize the learning environment and to display student work publicly (USDOE, 2011). These new recommendations reflect the idea that we cannot progress with a static education system and a stagnant relationship with our students.

Figure 1 U.S. and international performance in math, science, and reading. Adapted from graphs published in "The Condition of Education 2006: U.S. Student and Adult Performance on International Assessments of Education Achievement" by M. Lemke and P. Gonzales, 2006, p.11,16,22. (NCES 2006073). Retrieved from the U.S. Department of Education, National Center for Education Statistics website: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006073

Innovation in modes of education requires innovation in settings for education, i.e., in the building typology of schools. The inadequacy of the current education system is highlighted by the inadequacy of our school environments. While teachers and administrators strive to overcome achievement gaps with new instructional strategies they are confronted by the inflexibility of their buildings. A recent survey of educational facilities found that thirty-seven percent of schools use portable facilities, although less than half of those are overenrolled or at capacity (Chaney & Lewis, 2007). Most of these schools cite attempts to lower class sizes, add support services, or vary instructional strategies as the reason for needing more space (Chaney & Lewis, 2007). This surprising statistic quoted above indicates that crowding is not always the motive for schools using portable facilities. Put shortly, current standardized facilities do not accommodate the variable programming required in education today.

The new small learning communities which host varied instructional programming with a focus not on the general anonymous classroom, but on the individual learner demand a new type of space. This space, by definition, must host variety. Small learning communities prioritize the individual learner and can be characterized by a focused effort to address the environmental implications of customized education. The U.S. Department of Education (2011) lists 'the personalization of the learning

environment' as a condition necessary to the success of the movement.

1.2 THE LEARNING ENVIRONMENT

Research has shown that the environment has a powerful effect on the user both physiologically as well as psychologically and also alters the nature of the activities that are housed within it. This is especially relevant in a school environment where students spend inordinate amounts of time in spaces which they have little or no power to alter, yet which hold the power to alter them.

Many schools find their classroom environments inadequate to address certain teaching and learning conditions due to space limitations, storage issues, or the room lacking specificity to program as in the case of a science lab (Chaney & Lewis, 2007). Schools need a variety of teaching and learning environments to host small group instruction, tutoring, lectures, labs, and other activities - rather than a series of generic, replicated spaces.

The character of these environments must be well designed in terms of programmatic function but must also consider their physiological impact on the user. Elements in the environment such as color and the character of available light alter hormone levels, heart and pulse rate, body temperature, the level of interest and engagement with work, and are even correlated with measurements of IQ (Mahnke, 1996; Baird &

Lutkus, 1982; Holtzschue, 2006). It is important to consider the learner at this most basic physiological level when designing the space.

Further, one must consider spaces' psychological impact on the user. Researchers in the field of visual rhetoric have shown that objects and images are all imbued with values. These elements, which comprise our environment, therefore become communicative (Hill & Helmers, 2004). Whether intended or unintended, messages are embedded in our built environment, and research tells us that students receive these messages and use this information to produce judgments about themselves and others in their environment (Preiser, Rabinowitz, & White, 1988; Laroque, 2008; Castonguay & Jutras, 2009; Pitner & Astor, 2008). It is important that the messages we send students attribute value to the students themselves and their learning process, and communicate the warm, welcoming environment that is shown to affect students' learning outcomes.

PART 1

The Perception of Space

RESEARCH

CHAPTER 2
FUNCTION

2.1 LEARNING MODALITIES and EDUCATIONAL PHILOSOPHIES

It is important to understand the way that information is presented to children and the way they incorporate it into their understanding of the world. Simply put, children do not all learn the same way; therefore, the environment cannot be uniform in the way it accommodates learning.

Learning modalities can be loosely grouped into auditory, visual, and kinesthetic. However, Howard Gardner's theory of multiple intelligences breaks these categories down further into eight separate areas. His categories (see figure 2) are: linguistic, logical, musical, spatial, kinesthetic, interpersonal, intrapersonal, and naturalist (Hutinger, 2001). It is important to understand that even though these categories can be clearly defined, rarely is a child wholly of one intelligence. These ways of understanding the world are easily translated into teaching methodologies; overall, children learn best when information is introduced through several of these methods used in combination.

***Linguistic/Language**: learns by listening, reading, verbalizing, enjoys discussion, likes word games, books, and records, and remembers verses, lyrics, and trivia*

***Logical/Mathematical**: thinks conceptually, uses clear reasoning, looks for abstract patterns and relationships, likes experimenting and testing things, likes classifying and categorizing*

***Musical**: thinks in tones, learnins through rhythm and melody, enjoys playing musical instruments, remembers songs, and notics non-verbal sounds in the environment*

***Spatial**: likes mazes and jigsaw puzzles, likes to draw and design things, likes to build models, and likes films, slides, videos, diagrams, maps, and charts*

***Bodily/Kinesthetic**: processes knowledge through bodily sensations, communicates through gestures, moves or fidgets while sitting, learns by touching and manipulating, likes role playing, creative movement, and physical activity, enjoys fixing and building things*

***Interpersonal**: understands and cares about people, is the social child, has lots of friends, and learns from cooperative learning experiences, and likes group games*

***Intrapersonal**: enjoys working independently, likes to be alone, appears to be self-motivated, and needs quiet space and time*

***Naturalist**: investigates, experiments, questions, and finds out about elements of science, the phenomena of the natural world, weather patterns, growing things, animals, conditions that change characteristics (water changes from liquid to solid when frozen)*

from http://www.pbs.org/teachers/earlychildhood/articles/learningmodalities.html

Figure 2 Definitions of Howard Gardner's multiple intelligence categories. From "Learning Modalities: Pathways to Effective Learning" by P. Hutinger, 2001. Retrieved from PBS Teachers website.

Variation in teaching method commonly characterizes the primary years, but becomes more difficult as the information to be conveyed grows increasingly complex. By the time that students reach high school, information is traditionally delivered in a group setting and in a lecture format. It is important that the environment afford every opportunity for teachers to challenge this narrow practice in order more effectively to reach the greatest number of students.

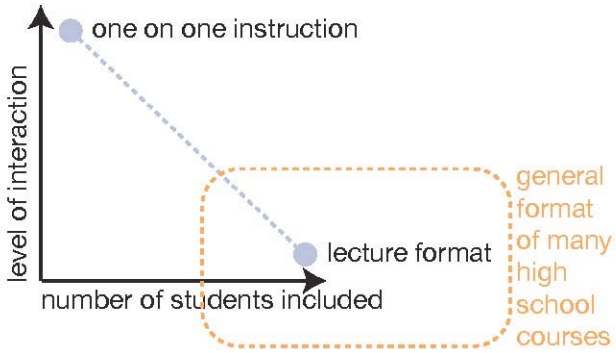

Figure 3 Correlation between the number of students addressed and the level of interaction afforded by the presentation method.

Most curricular presentations are driven by two factors: the nature of the curriculum and the educational philosophy to which the teacher

subscribes. Educational philosophy is first and most broadly categorized according to whether it is teacher- or student-focused (see figure 4).

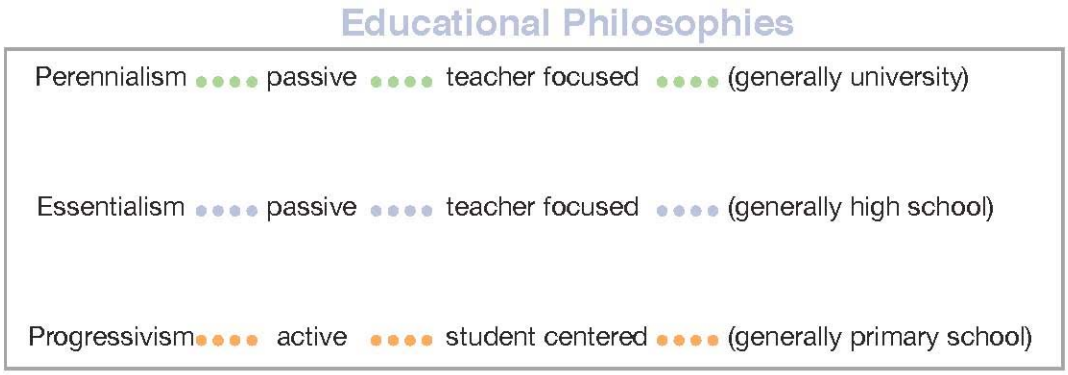

Figure 4 Educational philosophies. Adapted from "Philosophical Perspectives in Education: Educational Philosophies" by L. M. Cohen, 1999. Retrieved from Oregon State University website: http://oregonstate.edu/instruct/ed416/PP3.html

Two common teacher-centered philosophies are perennialism and essentialism. Perennialism is focused on the transmission of knowledge considered integral to the development of western civilization. As Cohen (1999) writes, "the loftiest accomplishments of humankind are emphasized – the great works of literature and art, the laws or principles of science" (para. 2). Essentialism, as the name suggests, focuses on the development of basic academic skills. This philosophy also incorporates traditional values inherent in the school experience such as respect for authority and the development of certain habits and behaviors. It can be seen as similar to and easily combined with perennialism.

Progressivism is one of the most common student-centered philosophies. The focus is on understanding information through interaction with the material. Learning is often student driven with inquiry authoring learning exercises (Cohen, 1999).

It is important that student learning modalities be paired with types of curricular instruction and complemented by the environment. Supporters of Reggio Emilia, a preschool educational philosophy, believe that the environment is the 'third teacher', because of its strong correlation with student interest and inquiry (Strong-Wilson, T. & Ellis, J., 2007). The preponderance of research demonstrates the belief in the impact of the environment on learning, and it is important that designers incorporate this knowledge across school environments.

2.2 ANTHROPOMETRICS

The school is arguably the domain of the child. A child's success is affected by his or her sense of belonging within the environment, as well as by how warm and welcoming the child senses the environment to be. One way to communicate clearly to the child that the school is tailored to his or her success is to address the child's physical needs within the space. Children, even at the high school level, have not yet reached adult stature. By understanding the unique proportions of boys and girls, we

can better design for their comfort, and in so doing promote learning success.

Children go through a great deal of physical change during their years in high school. The majority of children will grow nearly a foot in height from ninth to twelfth grade (Cain Ruth, 2000). Further, the growth charts below (see figures 1 and 2) reveal, for example, that in boys at age fourteen there are twelve inches between the fifth and ninety-fifth percentiles. This is the greatest spread manifest over the duration of childhood. At age six, for example, the spread between the fifth and ninety-fifth percentiles is only six inches, and at eighteen the spread has been reduced to eight inches. Girls manifest the same pattern, where the greatest spread appears at age fourteen, in the amount of ten inches, and then reduces to eight inches by age eighteen (Cain Ruth, 2000).

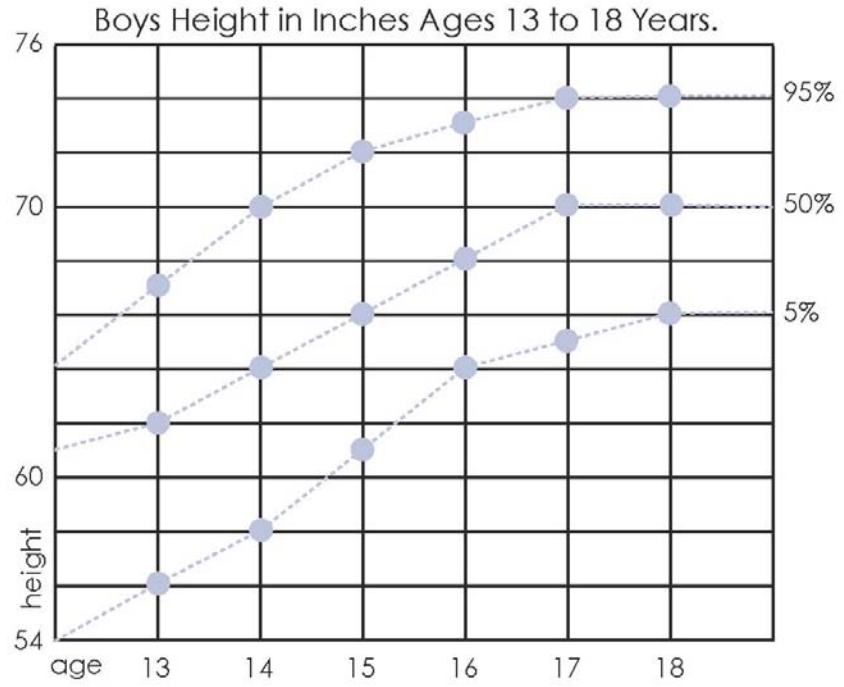

Figure 5 Growth chart showing height in inches of boys ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.5.

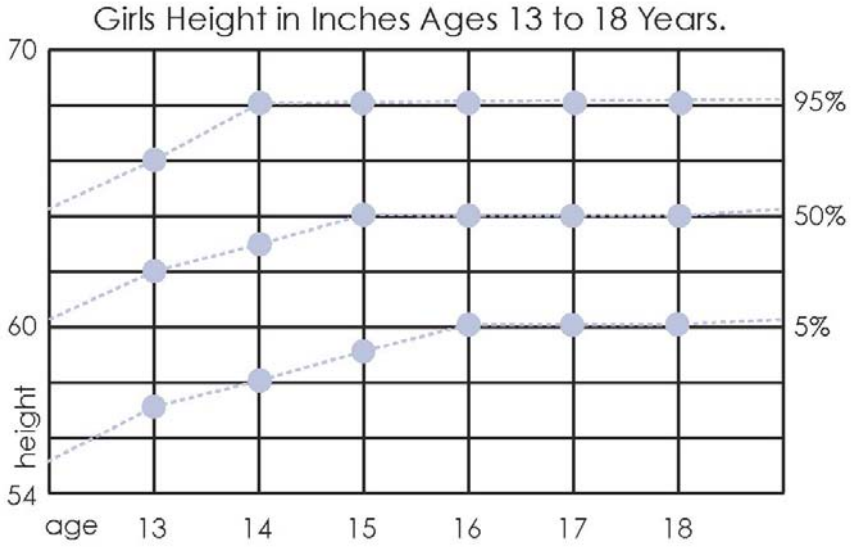

Figure 6 Growth chart showing height in inches of girls ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p. 5.

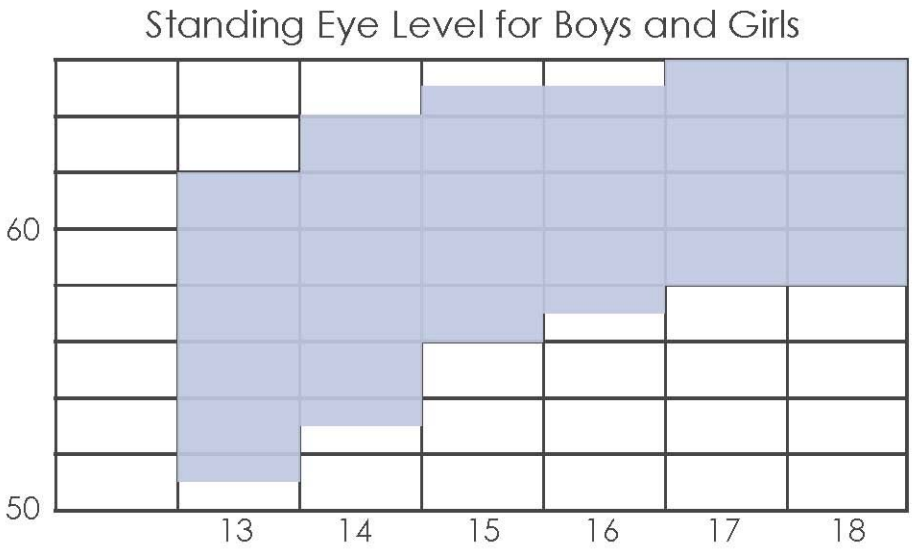

Figure 7 Standing eye level in inches for students ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p. 7.

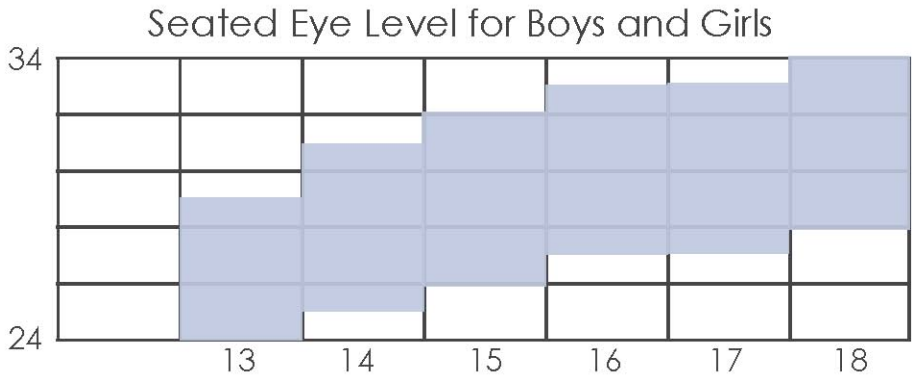

Figure 8 Seated eye level in inches for students ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.11.

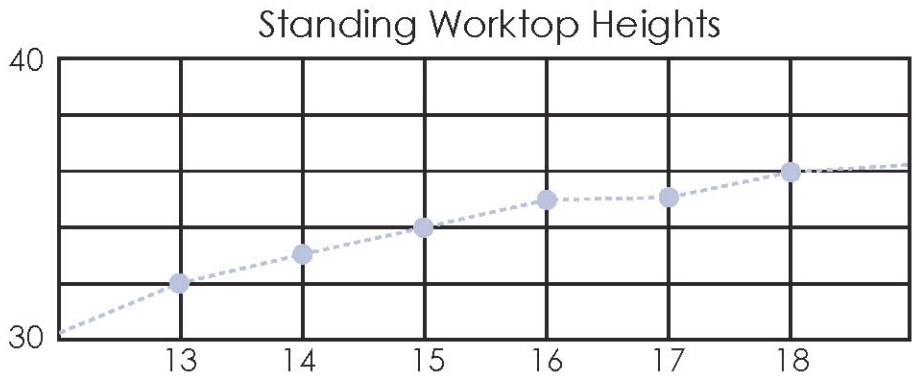

Figure 9 Worktop heights in inches for students ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.23.

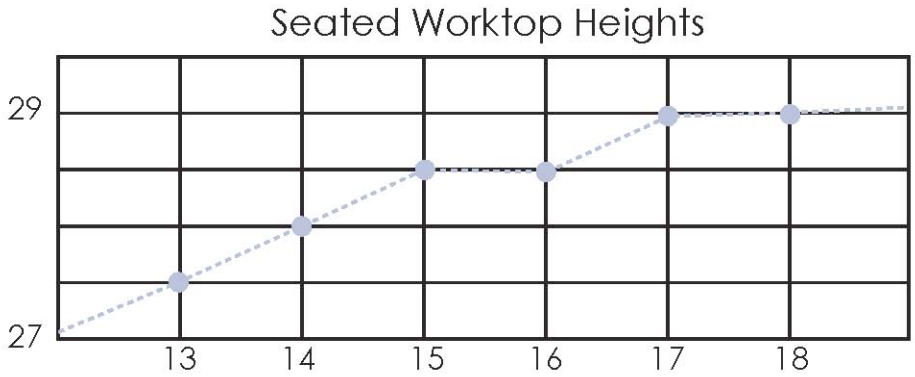

Figure 10 Seated worktop heights in inches for students ages13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.24.

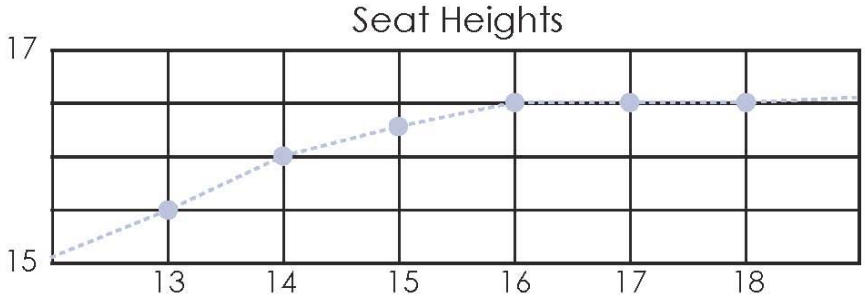

Figure 11 Average seat heights in inches for students ages13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.27.

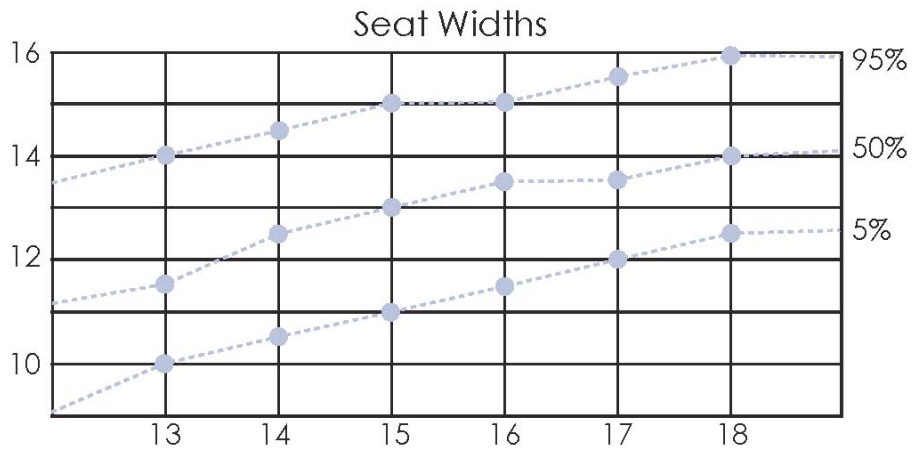

Figure 12 Seat widths in inches for students ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.26.

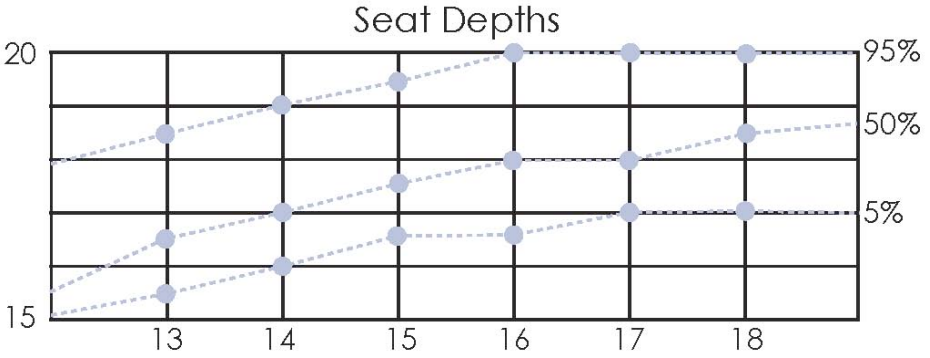

Figure 13 Seat depths in inches for students ages 13-18. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.27.

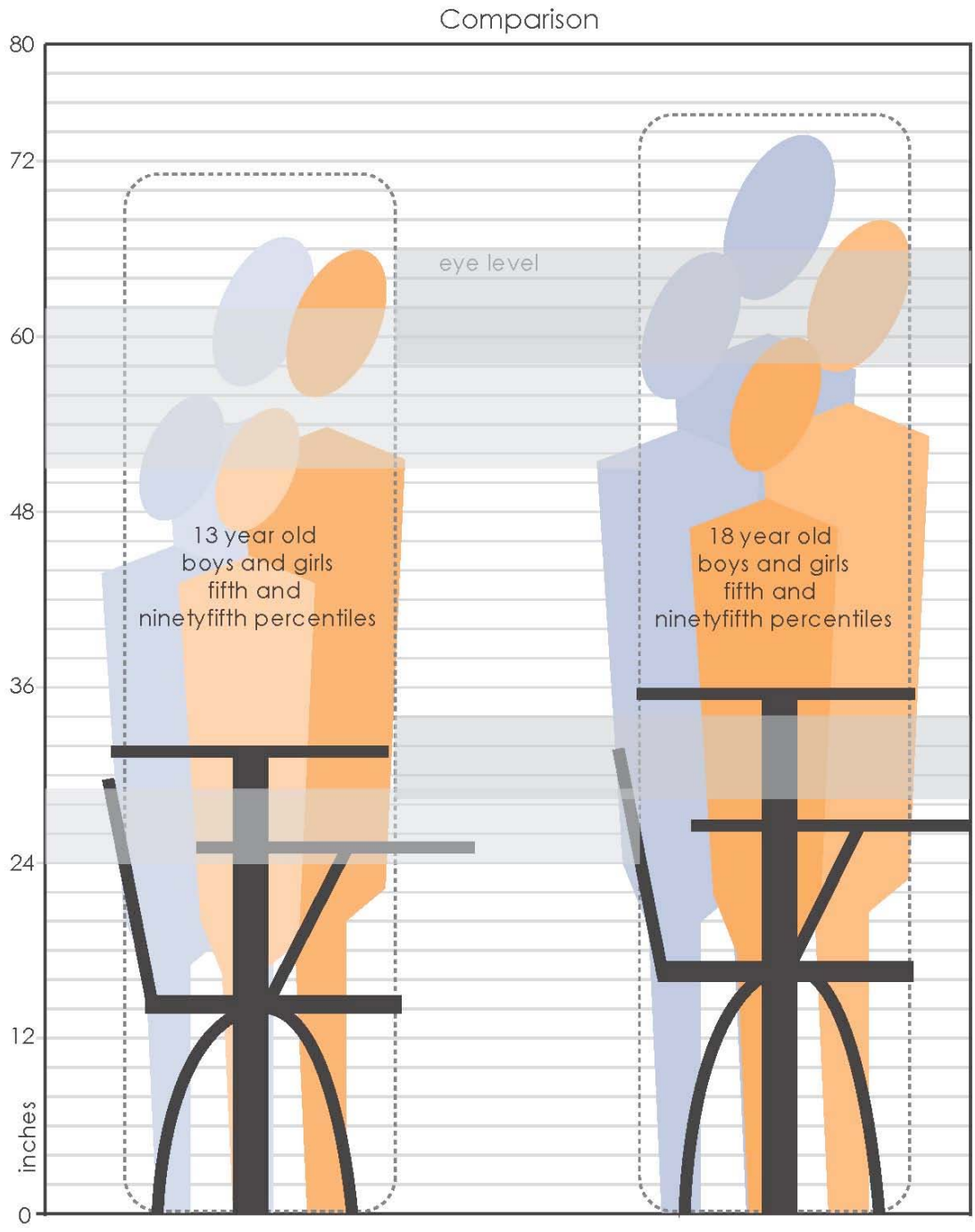

Figure 14: Compilation of anthropometric data, in inches, for comparison. Student height is offered for the fifth and ninety-fifth percentiles. The chair height, seated and standing worktop heights, and seated and standing eye level heights are the average for the age. Adapted from *Design Standards for Children's Environments* by L. Cain Ruth, 2000, p.5-27.

2.3 PROXEMICS

As many theorists have noted, behavior is contextualized to the environment, and many people exhibit predictable patterns in their activities (Duerk, 1993). Environmental pressures often condition social interactions, and can even encourage or inhibit social activity.

One factor that affects the educational environment is the simple issue of personal distance. Edward T. Hall (1966, cited in Lawson, 2001) characterized space according to the distance from the individual and proposed four main categories of space: intimate, personal, social, and public (see figure 15). Intimate distance is reserved for people with whom one is closely connected. In this space one can touch, smell, and whisper to the other person (Lawson, 2001, 115). As Bryan Lawson notes, "it is a distance that we enter normally only with permission" (115). Since it is a space typically reserved for trusted relationships, people generally make efforts to break connections when strangers invade this space. An example would be avoiding eye contact on the elevator (116).

The next distance is termed 'personal distance' and is a general conversational distance among friends. While somewhat broader than intimate distance it still represents a space reserved for trusted interactions (117).

Beyond personal distance lies social distance, a comfortable distance in which to have a conversation with a new acquaintance (118).

Generally speaking, public interactions respect this distance. This is of particular relevance in the school setting. Lawson notes this as being an ideal distance for small group discussion and asserts "...beyond this distance our sense of contact with other people gets lost"(118). He states, "beyond this distance we effectively relinquish our hold over or contact with other people in space, and can ignore them without infringing on etiquette"(119).

Hall's last category is termed public space. Lawson describes it as "the distance at which we ignore other people in space"(119). At this distance conversation requires a raised voice, and is usually reserved for performance or presentation.

This typology of spaces according to proxemics has particular relevance in the school setting. A standard classroom setup allows some portion of the students, not coincidentally those who are stereotyped as less engaged and lower performing, to occupy the 'public distance' which Lawson characterized in terms of the ease at which we can and do ignore people.

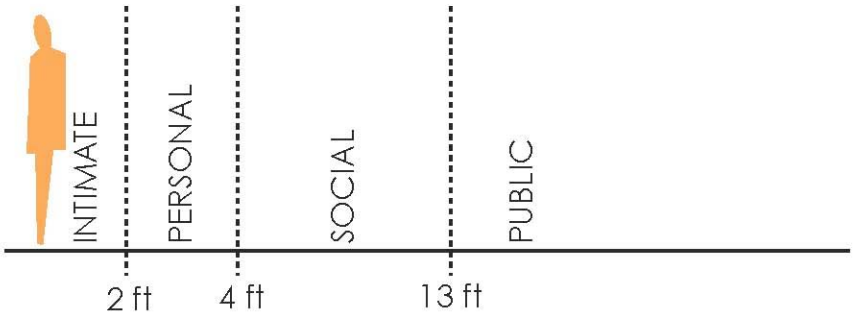

Figure 15 Distances that characterize social interactions. Adapted from *The Language of Space* by B. Lawson, 2001, p.115-119.

In addition to distance, there are other classifications of space according to their power to either encourage or inhibit social interactions. Space that encourages social interactions is referred to as "sociopetal" space while space that inhibits interactions is termed "sociofugal."

Sociopetal space takes advantage of the close social distance conducive to conversation but also relies on spatial configuration to encourage interaction. People are more likely to converse when they are slightly angled away from one another (see figure 16). This gentle angle provides a comfortable opportunity to break the interaction when desired. When people no longer feel the pressure of a forced interaction, they are more likely to engage with one another (Brebner, 1982).

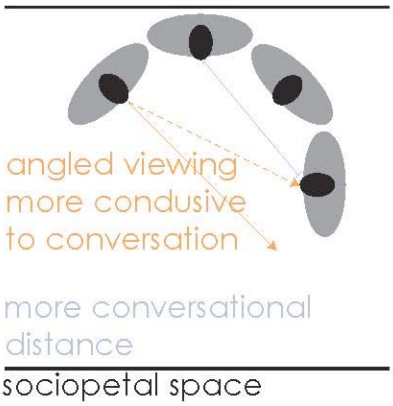

Figure 16 Sociopetal space in plan. Adapted from *Environmental Psychology in Building Design* by J. Brebner, 1982, p.129.

Conversely, when strangers are placed face to face they generally resist interaction (see figure 17). This placement makes breaking off the conversation too hard, overly pressuring the interaction, and it is consequently avoided (Brebner, 1982). When individuals are placed side by side, conversation is also unlikely due to the lack of eye contact. The example Brebner (1982) provides is of airport waiting space. The seats are placed in rows, just outside of conversational distance and are in a face-to-face orientation. Each of these factors is considered sociofugal. This design purposefully limits social interaction (Brebner, 1982).

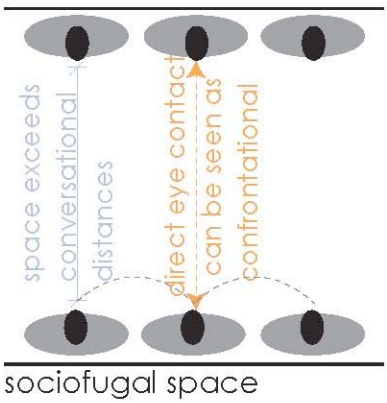

Figure 17 Sociofugal space in plan. Adapted from *Environmental Psychology in Building Design* by J. Brebner, 1982, p.129.

As education moves towards more personal and interactive learning environments it will be important to reconsider the classroom setup in these terms.

CHAPTER 3
PHYSIOLOGICAL IMPACT

3.1 A CASE STUDY: COLOR

Color, though frequently considered a last minute detail, has tremendous implications for the experience of space. Color has been shown to elicit physiological responses from the body, and as quoted in Frank Mahnke's book Color, Environment, and Human Response, "Seldom, surely, is the psychological part of an appearance in nature so great as it is in the case of color. No one can encounter it and stay neutral. We are immediately, instinctively, and emotionally moved. We have sympathy or antipathy, pleasure or disapproval within us as soon as we perceive colors"(Beer, 1992 as cited in Mahnke, 1996, p.6).

Color, while immaterial, exhibits power over the human experience. Additionally, some limited research has been done on patterns, which has yielded findings of innate biological responses as well. In time, perhaps we will have a similarly extensive body of research to confirm long-held opinions about responses to material and texture that will broaden our ability to make informed design decisions and to more precisely calibrate design intent. Until that time, we will extrapolate from the research on color.

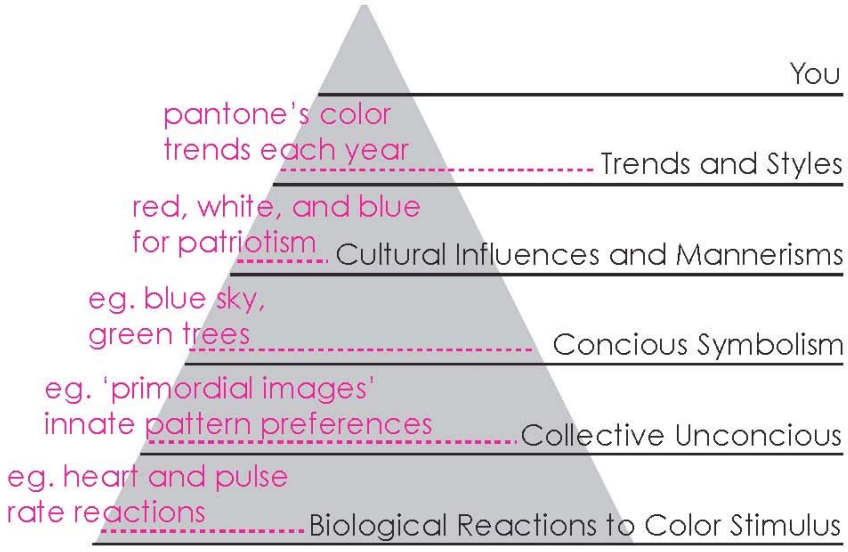

Figure 18 Frank Mahnke's color stimulus triangle. Adapted from *Color, Environment, and Human Response: An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment* by F. H. Mahnke,1996, p.11.

Mahnke (1996) begins by addressing the complexities of interpretation. While his triangle (see figure 18) is specific to color, the same process could be applied to the interpretation of most elements in the environment. Even after sorting through biological reactions, symbolism, and trends, there, at the apex of the triangle, one must begin the process within each individual. Each individual must reckon with his or her own collage of personal experiences before arriving at a final interpretation. While this raises again the argument in favor of variety within the environment, it must be paired with the compelling body of research that lends some necessary degree of predictability to the field.

Color can affect heart rate, pulse rate, IQ, and even body temperature (Mahnke, 1996). Three separate studies confirmed the effect of color alone in determining thermal comfort levels (see figure 19). A simple coat of paint varied the perception of temperature by as much as seven degrees Fahrenheit (Mahnke, 1996, p.73-74). In another two studies judgments on the passage of time varied by as much as forty-five minutes in the wrong direction according to the color of the room. In one example, those in a red room felt that their meeting/event was engaging and that the time had passed very quickly, while those in a blue room reported boredom and estimated they had been in the room much longer than they in fact had (Porter & Mikellides, 1976 as cited in Mahnke, 1996, p.71). Even considering the personal matter of color preference there exist many commonalities. In a large study by Heinrich Frieling students rated their color preferences. Students were surprisingly consistent in their choices (see figure 20). The students overwhelmingly rejected black, white, gray, and brown (Mahnke, 1996, p.181-182).

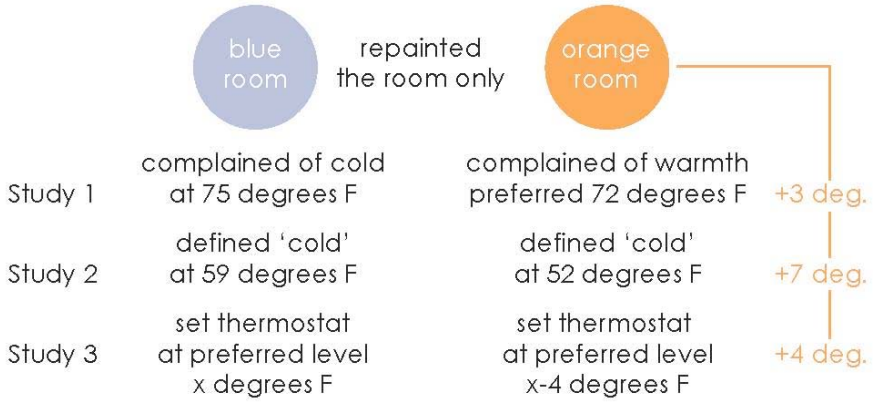

Figure 19 Compilation of results of three studies on thermal comfort and color. Adapted from *Color, Environment, and Human Response: An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment* by F. H. Mahnke,1996, p.71-74.

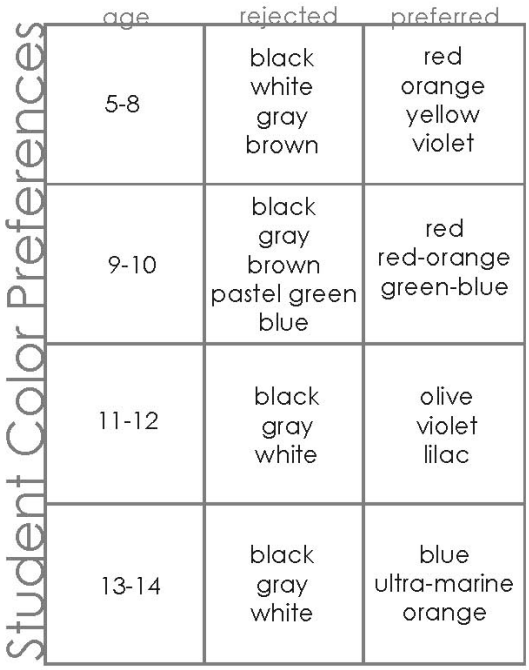

Figure 20 Results of Heinrich Frieling's study regarding color preference in students. Adapted from *Color, Environment, and Human Response: An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment* by F. H. Mahnke,1996, p.182.

Color, it must be remembered, is one element in an overall environment. It is a tool to express a certain condition or character and to increase or decrease the level of visual stimulation in a space. A focus on the level of stimulation, rather than a specific color choice, is perhaps the most relevant application of this research, and raises again the issue of variety.

Many authors argue for complexity rather than prescribe specific hues. In Mind Child Architecture, Baird and Lutkus (1982) reference studies that correlated the presentation of visual stimulus with the perceptual and motor development of infants. In another study children in deprived visual environments were tested to have lower IQ's than those in visually rich environments. Tellingly, this result could be altered by the presentation of visual stimulus to the lower performing children. At the end of his study on the subject, Rikard Kuller (1976) concluded "[overstimulation] can cause changes in the rate of breathing, pulse rate, and blood pressure; increase in muscle tension; and psychiatric reactions of various types"(as cited in Mahnke, 1996, 23). Likewise, "persons subjected to understimulation show symptoms of anxiety, restlessness, excessive emotional responses, difficulty in concentration, irritation…"(24). He exhorts, "this should be considered very seriously by those who propose a white or neutral environment; such environments are anything but neutral in the effects they have on their occupants"(24).

The argument for variety deepens. Crewdon (1953) writes, "balance is the securing of unity in the midst of variety. Both variety and unity are necessary to sustain interest, and these opposing forces must be balanced. Variety is necessary to attract and arouse interest; unity is essential to create a favorable impression and to satisfy the moods and desires. Variety overdone is confusing and unpleasant; unity overdone is monotonous. The mark of a good color arrangement is knowing where to stop between these two extremes"(as cited in Mahnke, 1996, 26).

Schools typify the condition of unity. They typically comprise a series of monotonous classrooms, identical in size, shape, and color. Teachers arrive on the first day of school with yards of fabric, rolls of posters, and anything else they can find to invigorate their lifeless rooms.

The inclusion of variety in classrooms is clearly supported by research although it has not found its way fully into practice. In 1983 Harry Wohlfarth studied the effects of color and lighting in classrooms from both academic and physiological standpoints (as cited in Mahnke 1996). Not only was performance measured, but also IQ and blood pressure. In four classrooms he varied the combination of psychodynamic colors and full spectrum lighting (see figure 21). The students in the control room, finished in neutrals and using artificial light, performed the worst. The students with the benefit of psychodynamic colors as well as full spectrum lighting outperformed all the other students. It is interesting to note that the

students in the classrooms where only color was applied outperformed the students where only full-spectrum light was applied. While more studies need to be completed in the area, the results remain very compelling (Mahnke, 1996, 182).

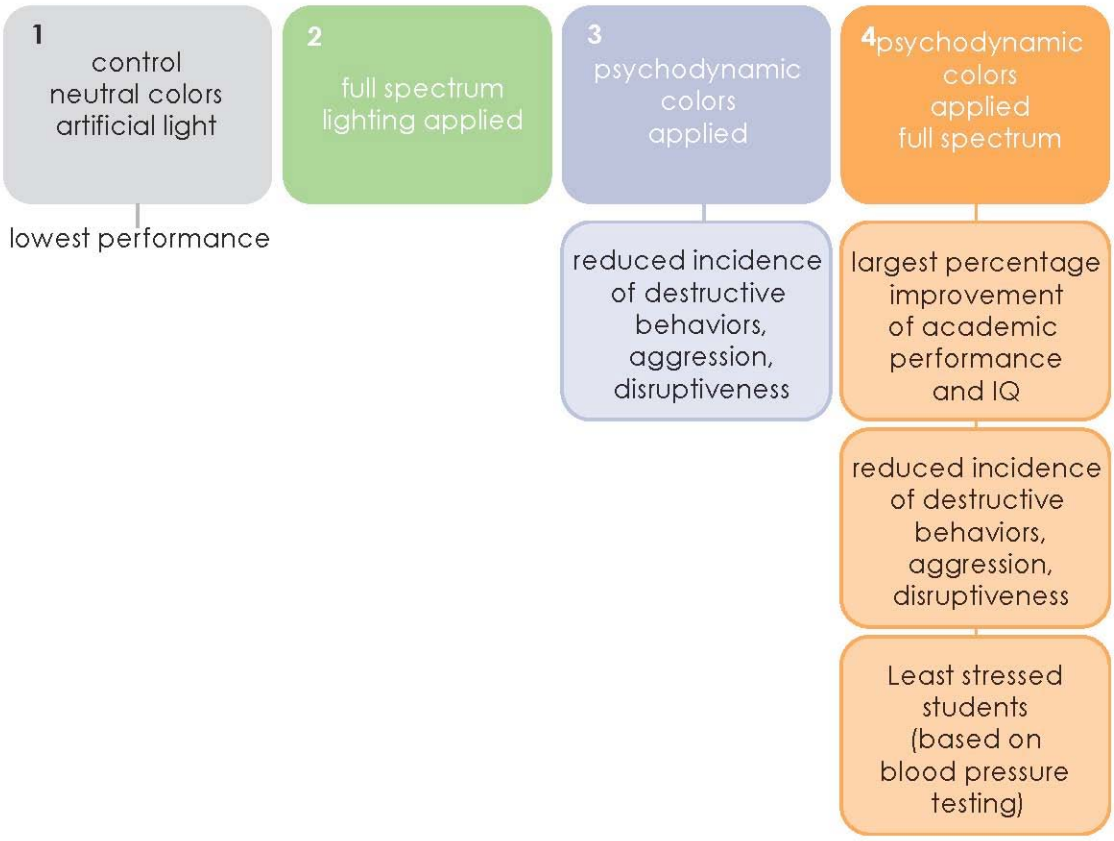

Figure 21 Results of Harry Wohlfarth's 1983 study on lighting and color in classrooms. Adapted from *Color, Environment, and Human Response: An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment* by F. H. Mahnke,1996, p. 182.

Figure 22 Results of Ertel's 1973 study on environment and IQ testing. Adapted from *Environmental Psychology in Building Design* by J. Brebner, 1982, p.162.

Even the need for simple variety according to personality or mood and not necessarily psychodynamic prescription is supported in research. In a study by Ertel (1973 as cited in Brebner, 1982) children were tested in different color rooms. When tested in "colorful rooms which were liked by the children" the children tested twelve points better than the average on the IQ tests (162). When tested in "black, white, or brown rooms, which the children are reported not to have liked" students tested fourteen points worse than the average (Brebner 1982, 162).

It is important now to consider creating variety among the spaces for character, the well-being of the student, and the intended function to be housed. As Mahnke sums, "monotonous environments are totally misplaced for the well-being of the user from both psychological and physiological standpoints"(Mahnke, 1996, 25).

CHAPTER 4
PSYCHOLOGICAL IMPACT

The learning environment must be considered beyond mere function. While the psychological effects of design may be difficult to quantify they cannot be discounted. As Charles Hill (2004) points out, "…binary distinctions such as 'emotional and rational' have been problematized in the theoretical literature and demonstrated as invalid by much of the empirical research into cognitive and neurological processes"(Hill & Helmers, 2004, 27). Emotional responses are rooted in concrete experiences and physiological reactions, and are valuable "evolutionary adaptations"(33-35). As advertising and marketing professionals have long been aware, they are frequently predictable and very powerful in determining behavior (Hill & Helmers, 2004). Designers must consider the psychological context of design to assure that they are planning effectively for students.

4.1 TERRITORIALITY

Territoriality primarily relates to a sense of ownership and the ability to exhibit control over the physical environment. Caretaking, for example, can be seen as a territorial behavior. However, in the context of the school system I am using the term to mean more. For students,, I am also referring to a sense of belonging within the environment. This sense of

belonging and ownership is positively correlated with student learning outcomes and thus it becomes important to understand the role of territoriality in the educational system and how the design of learning environments can facilitate it.

In the book The Significance of Territory (1973), Jean Gottman writes, "civilized people ... have always partitioned the space around them carefully to set themselves apart from their neighbors. At the earliest stages this area thus demarcated was meant to serve as the 'home' ... a shelter against aggression by outsiders ... and the area where from the resources for survival were to be obtained"(1). As Gottman elaborates, once the territory is established, the argument shifts to "environmental organization for happiness"(95). The comparison is made to Aristotle's description of the Greek city-state, "originating in the bare needs of life, and continuing in existence for the sake of a good life"(Gottman, 2). This argument foregrounds the issue that one must first feel a secure sense of ownership – or, if not ownership, belonging - within the environment before one can begin to develop further.

Robert Hershberger (1999) makes a similar argument. He superimposes Aristotle's three part progression in the search for the 'good life' on Maslow's hierarchy to demonstrate that only when an individual has a secure sense of belonging in the environment can he or she progress beyond mere survival in development (see figure 23). Sense of

belonging in Maslow's hierarchy precedes the development of self-esteem and self-actualization.

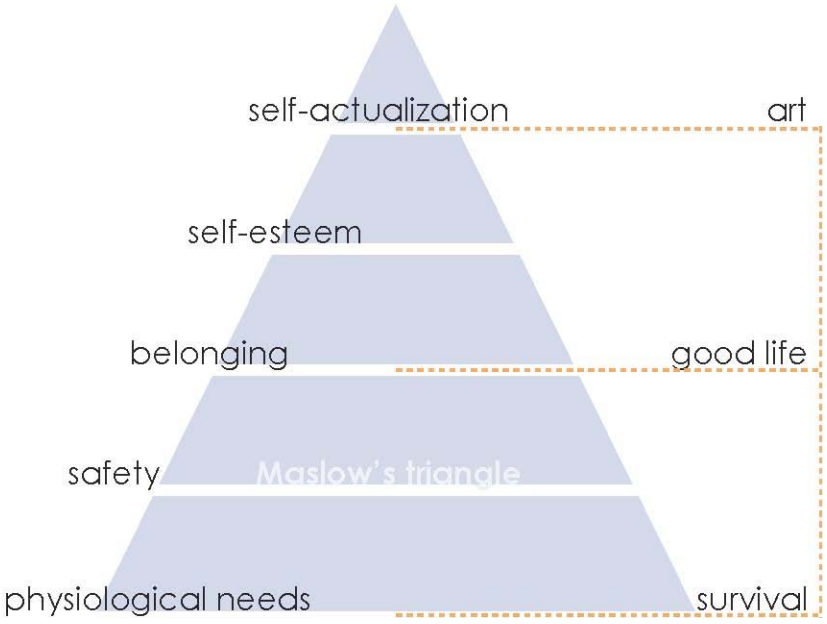

Figure 23 Robert Hershberger's pyramid. Adapted from *Architectural Programming and Predesign Manager* by R. Hershberger, 1999, p.43.

It is not surprising to discover that this sense of belonging is important in the school environment as well. It has been shown that students' engagement with schoolwork is positively correlated with their perception of control and ownership at school. As one article states, "the construct sense of ownership consists of the ability to have control over the learning environment, to personalize the environment, to express territoriality, and to be involved in one's learning" (Killeen, Evans, & Danko, 2003).

Traditionally, ownership in a school environment has been developed through a role in the educational process. However, research demonstrates that this sense of ownership can also be developed through participation in the design of the environment. Positive correlations were linked to intrinsic motivation as well as increased performance (Killeen et al, 2003).

Since control over the environment can be hard to offer students in the public school system, it is important to note further research has shown that learning outcomes are also positively correlated with representations of students within the environment. For example, the placement of student work in public places can provide a sense of belonging for the student that can lead to higher levels of motivation and performance (Killeen et al, 2003).

Further, research has demonstrated that, even as observers, children are able to read messages imbedded in the environment around them, and that they use that information to make judgments about others and themselves. In one study, positive judgments about the physical environment were correlated with positive judgments about the community, and most interestingly were tied to the student's self-concept (Castonguay & Jutras, 2009). As Castonguay and Jutras' study highlights, the physical environment was often judged and characterized by the condition of the relational environment (2009). Another study yielded

similar results. Children were asked to describe an environment based on photographs. Children correlated observations of caretaking behaviors with judgments about the community and the neighbors. Children created a causal relationship between caretaking and safety (Pitner & Astor, 2008). Pitner and Astor note, "[children believed] residents cared about that neighborhood that had signs of territoriality, and this is what made them safer"(335) They close, children's "moral attributions to physical settings follow a similar pattern that has long been associated with moral reasoning about behavioral acts"(Pitner & Astor, 2008, 335).

Another study regarding school climate yielded relevant results as well. School climate, defined as "the shared beliefs, values, and attitudes that shape interactions"(272), was found to have an impact on both teachers and students, although it had a more substantial impact on student morale (Mitchell, Bradshaw, & Leaf, 2010). Negative perceptions of school climate were viewed as a "signal to students and teachers that the environment is unstable or unsupportive"(272), and were correlated with student performance. Students, it is hypothesized, were more affected by school climate because of their limited sense of ownership in the school environment (Mitchell et al, 2010).

This has a strong connection to Gottman and Aristotle's reasoning about belonging as a precursor for success. We need to offer our students this sense of belonging and ownership in order to establish for

them a greater chance of academic success. Research shows this can be done by representing students in the environment and offering them opportunities to exhibit territorial behaviors such as environmental personalization, decision making, or caretaking.

4.2 IMAGE AND MEANING/WARM ENVIRONMENTS

In Post-Occupancy Evaluation (1988), Preiser, Rabinowitz, and White write, "in addition to the physiological impact of a building, there is a meaning attached to its design. Its shape, size, materials, details, and decoration form a kind of language, and just as language conveys meaning, so does a building"(46). The whole of space works together to communicate to the user certain messages. It is important to consider what messages we are sending students by the way we design learning environments.

In New Schools for New York (1992), a book assembled by the Architecture League of New York and the Public Education Association, which catalogues New York's first movements towards small learning communities, architects solicited opinions from parents and students on their vision for the design of new schools. Common requests were for a variety of bright, flexible spaces, but "most fervently requested was warm, welcoming, safe space for everyone"(Architectural League of New York & the Public Education Association, 1992, 28). The schools, in general, were

seeking a warm community environment, which was otherwise absent in the urban context and in the large school systems preceding the shift. One school in the Bronx had even divided its student body into groups, which they termed 'families,' and had requested spaces typical of a domestic commission, such as dining rooms and kitchens, for these groups to meet in. The design most celebrated for that school offered not only kitchens and dining rooms, but also living rooms complete with fireplaces to read by. The jury stated they most admired the design "for the nature of the spaces proposed and the attitudes about teachers and children that the spaces communicate. [Spaces] developed around themes of comfort" which are not institutional (Architectural League of New York & the Public Education Association, 1992, 32).

Many studies have supported the idea that students function best in "classrooms that are perceived as safe, warm, supportive, and non-threatening"(Charles 2002 cited in Laroque, 2008). Teachers often use furnishings to try to convey a sense of warmth to their students. Desk lamps, rugs, curtains, are frequently added to 'warm' the space, an action generally characterized by an effort to connect students to ideas of comfortable, personal environments such as home. While some part of this behavior can likely be linked to efforts at facilitating territoriality, it must also be acknowledged as a compensatory effort to achieve something that the design did not.

Readings in the field of visual rhetoric demonstrate that all objects and materials are imbued with certain values and messages (Hill & Helmers, 2004), and that it is impossible to recognize the former without referencing the emotions and associations which have been transferred to them over time (Hill & Helmers, 2004; Holtzschue, 2006).

It is important to consider the messages sent by an institutional or monotonous environment. The elements and materials in these schools, which have persisted due to cost or inflexible design guidelines, have taken on certain meanings linked over time to the larger characteristics of these institutions (Hill & Helmers 2004), characteristics that new educational philosophies deliberately reject.

The small learning communities movement seeks to change the impersonal and stereotypically institutional characteristics found in large schools. It requires the personalization of the learning environment and seeks to facilitate the positive relationships proven to aid in student success. Consequently it is time to redesign the learning environment and to capitalize on the materials that carry cultural values representing comfortable, warm, welcoming environments.

PART 2

Understanding the Charge

RESEARCH

CHAPTER 5
PRECEDENTS

5.1 INTERIOR ENVIRONMENTS: PRIMARY SCHOOLS

These projects provide a sampling of sites from the US, to Europe, to South America. Some are publicly funded while others are private, and one remains unbuilt.

Each of these schools was selected because of its sensitivity to the child's scale, the use of warm colors and materials, and the connection it makes to images of home and the outdoors.

Figure 24 Image adapted from Bjarke Ingels Group website, 2010. Title added.

Figure 25 Original image (figure 24) altered here to highlight specific areas of interest.

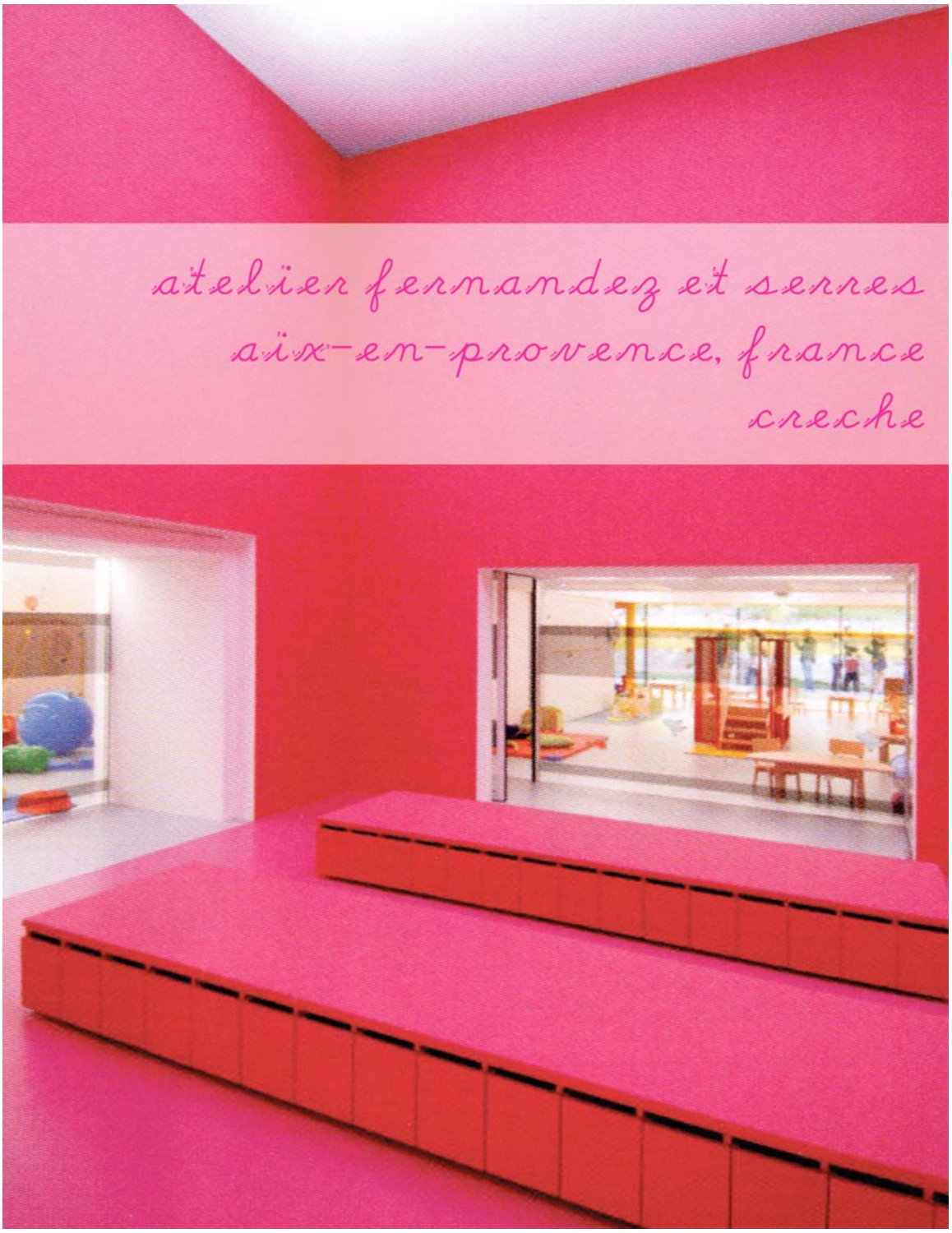

Figure 26 Image adapted from 2010, January, *AMC Le Moniteur, 193,* p. 200. Title added.

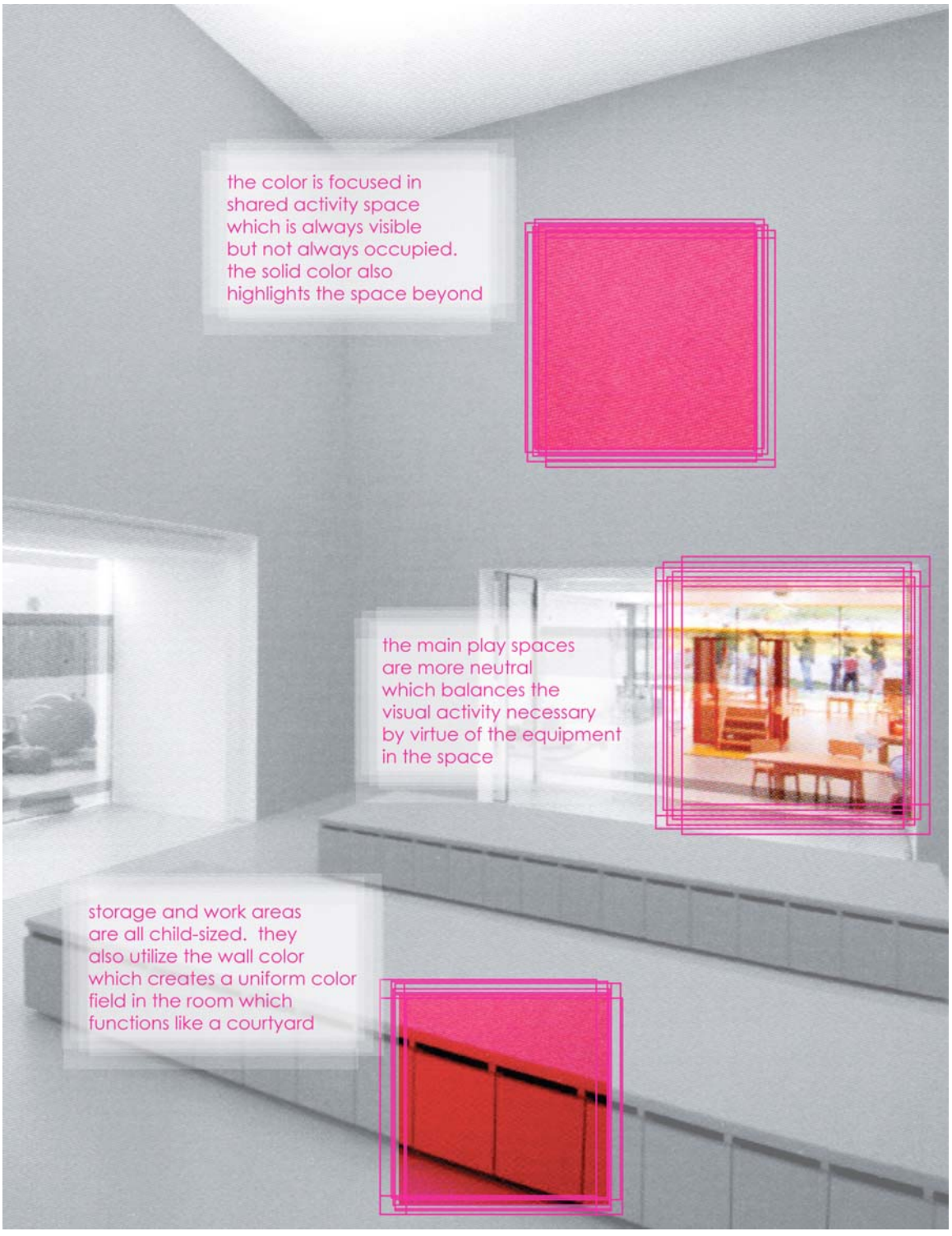

Figure 27 Original image (figure 26) altered here to highlight specific areas of interest.

Figure 28 Image adapted from “Ny Arkitektur: Förskolor” by M. Stannow, 2010, *Arkitektur, 110(3),* p.24-25. Title added.

Figure 29 Original image (figure 28) altered here to highlight specific areas of interest.

Figure 30 Image adapted from “Il Girontondo di Cemento” by C. Nuijsink, 2010, May, *Abitare, 502,* p.99. Title added.

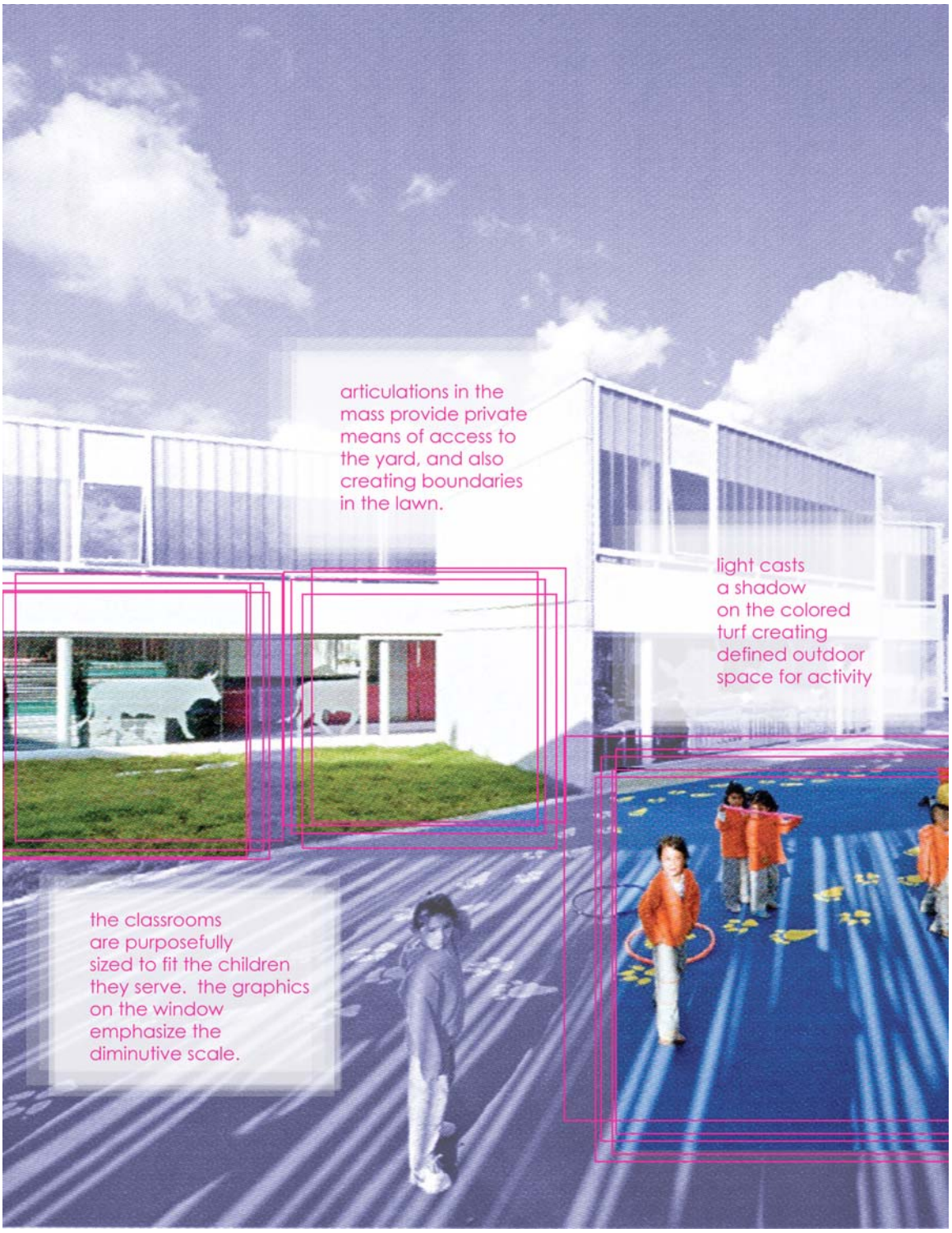

Figure 31 Original image (figure 30) altered here to highlight specific areas of interest.

Figure 32 Image adapted from Mahlum website, 2010. Title added.

Figure 33 Original image (figure 32) altered here to highlight specific areas of interest.

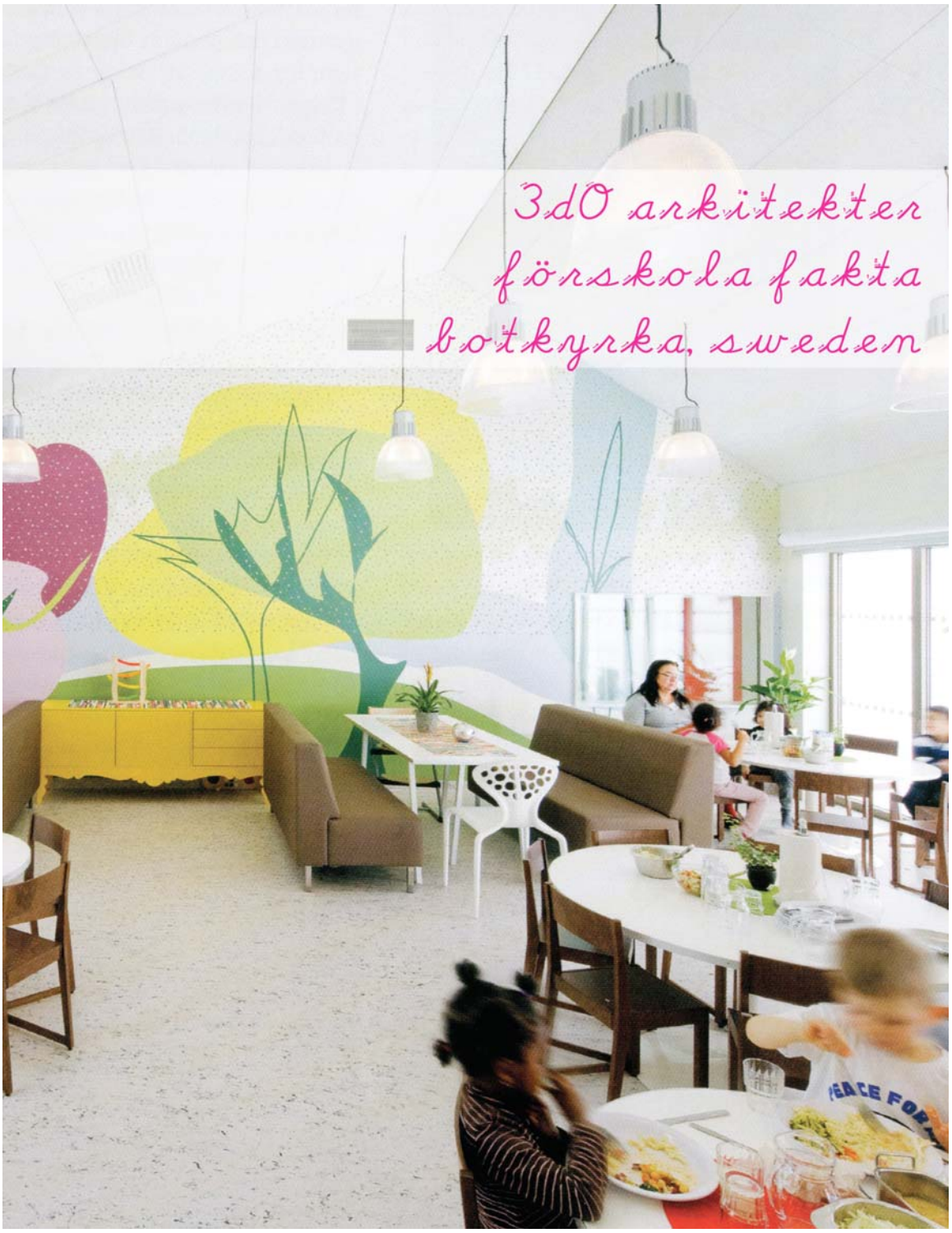

Figure 34 Image adapted from “Ny Arkitektur: Förskolor” by M. Stannow, 2010, *Arkitektur, 110(3),* p.35. Title added.

Figure 35 Original image (figure 34) altered here to highlight specific areas of interest.

5.2 ARCHITECTURAL RECORD SELECTED SCHOOLS

Each year Architectural Record selects schools to represent, in their words, "the latest thinking and best ideas on the planning and design of k-12 school buildings." They feature these schools in their annual issue "Schools of the 21st Century." The schools which are highlighted in the pages that follow were selected from the last ten years of that issue archived on the website www.archrecord.construction.com. As part of the collaborative portion of this project, these schools were selected in common, and were then examined independently through the filter of the individual research topics.

These projects are meant to serve as a sampling of what the profession considers quality design. Some represent ideas that are consistent with the implications of this paper, and others do not.

5.2.1 Betty H. Fairfax High School

Designed by DLR Group in Phoenix, Arizona, Betty H. Fairfax High School was designed as a campus housing three small learning communities. In this example, different departments were given separate facilities connected by exterior walkways. Within individual buildings students and staff are connected to the outdoors via extensive glazing.

Figure 36 Betty H. Fairfax High School. Image adapted from "College Prep: A Small School Approach to Education Yields a Campus Plan for a Quickly Growing District, by T. S. Bowen, n.d., Retrieved from http://archrecord.construction.com/schools/08_Betty-Fairfax.asp

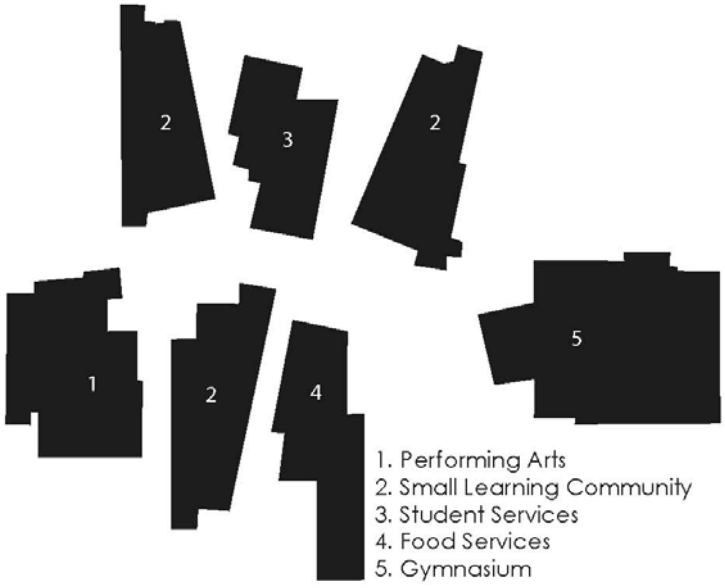

Figure 37 Campus plan based on the Partial Site Plan developed by DLR Group. Image adapted from "College Prep: A Small School Approach to Education Yields a Campus Plan for a Quickly Growing District, by T. S. Bowen, n.d., Retrieved from http://archrecord.construction.com/schools/08_Betty-Fairfax.asp

Inside the classroom buildings, natural light through large viewing windows and clerestories warms the otherwise cool environment. The open spaces in the corridor serve to provide relief from the uniformity of repetitious spaces (see figure 39). The recessed classroom openings provide articulation of the individual classroom space and re-orient students to the scale of the individual inside the larger context of the corridor (see figure 40).

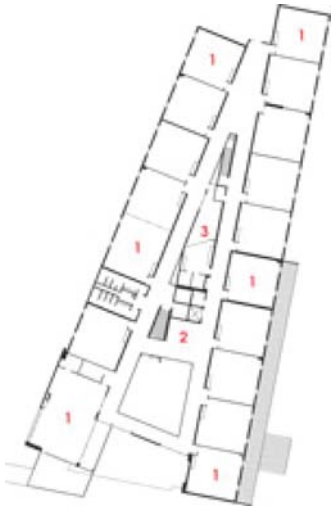

Figure 38 Second Floor Plan of the Small Learning Community created by DLR Group. Image adapted from "College Prep: A Small School Approach to Education Yields a Campus Plan for a Quickly Growing District, by T. S. Bowen, n.d., Retrieved from http://archrecord.construction.com/schools/08_Betty-Fairfax.asp

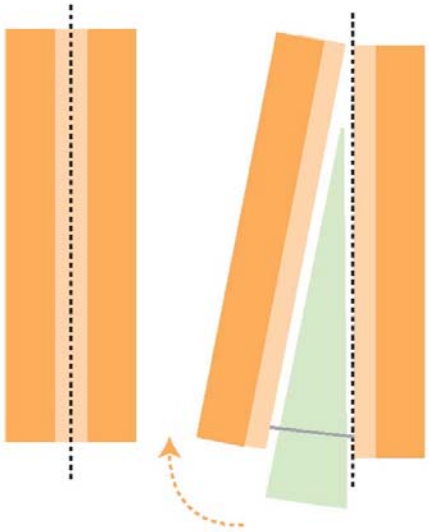

Figure 39 Diagram of the integration of natural light and views in the double loaded corridor. Based on Figure 38.

Figure 40 Interior View of the Small Learning Community. Image adapted from "College Prep: A Small School Approach to Education Yields a Campus Plan for a Quickly Growing District, by T. S. Bowen, n.d., Retrieved from http://archrecord.construction.com/schools/08_Betty-Fairfax.asp

5.2.2 Blythewood High School

Located in Columbia, South Carolina, Blythewood High School was designed by Perkins + Will, and also hosts four small learning communities. It is another plan featuring extensive glazing in order to maximize light in classroom spaces (see figure 41). In order to access even northern light in all classrooms, and meanwhile respect the boundaries of the adjacent lake and wetlands, classrooms are grouped and rotated off axis (see figure 42).

Thanks in large part to the glazing system the interior environment is clean, bright, and open. Students have reported, "'the building makes them feel smarter'"(Sullivan, n.d.).

Figure 41 Views of the interior environments featuring open, bright spaces. Adapted from "The Sum of Smaller Parts: On a Geographically Rich Site, a Quickly Growing South Carolina District Builds a Large High School with Intimate and Flexible Learning Environments" by C. C. Sullivan, n.d., Retrieved from http://archrecord.construction.com/schools/0701_CS2_blythewood-1.asp

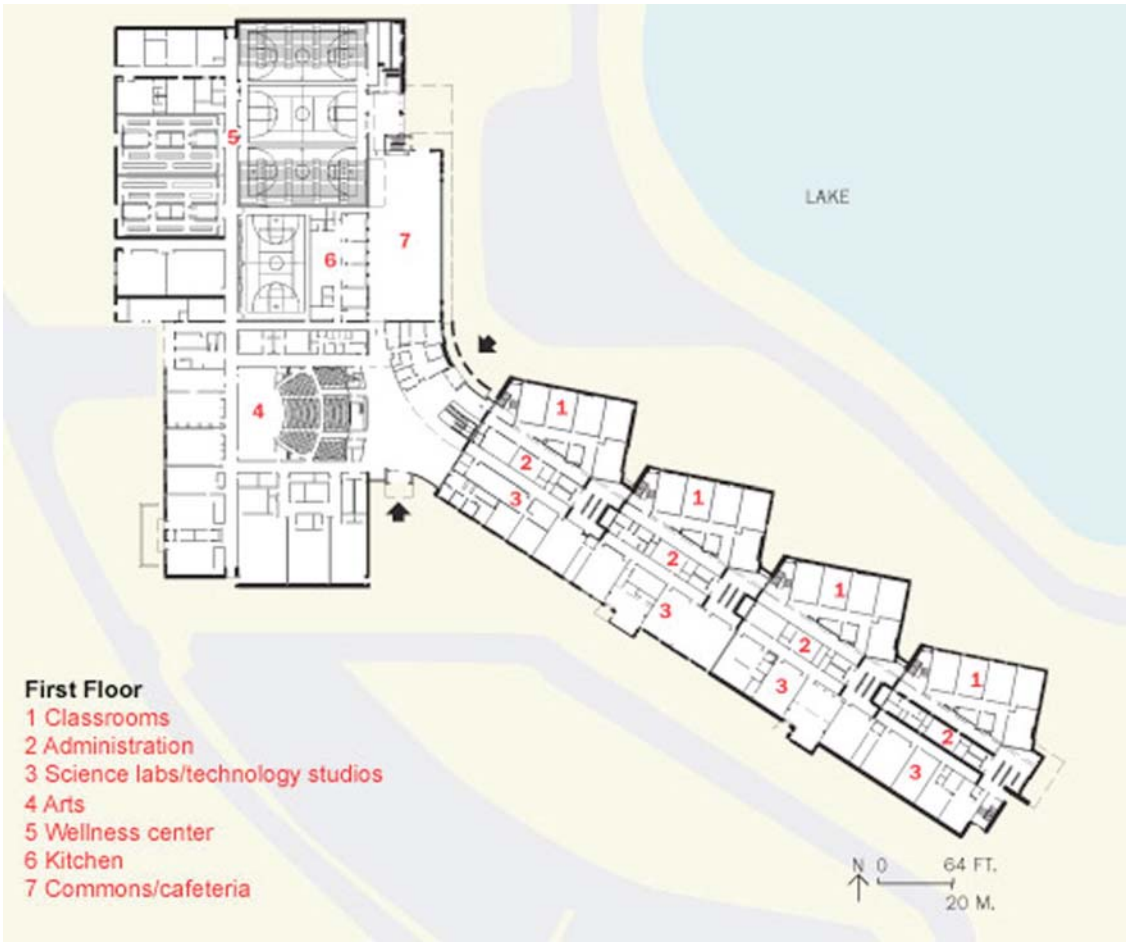

Figure 42 First floor plan. Adapted from "The Sum of Smaller Parts: On a Geographically Rich Site, a Quickly Growing South Carolina District Builds a Large High School with Intimate and Flexible Learning Environments" by C. C. Sullivan, n.d., Retrieved from http://archrecord.construction.com/schools/0701_CS2_blythewood-1.asp

5.2.3 Booker T. Washington High School

Designed by Allied Works Architecture this arts magnet school is situated in Dallas' urban arts district. The site is described as "an eight-lane freeway on one side, empty warehouses and vacant lots on

another" (Dillon, n.d.) Some refer to the project as an 'art factory'(Dillon, n.d.) and perhaps this paints a more vivid picture of the interior condition.

The project provides generous studio and rehearsal spaces, even equipping the cafeteria floor with springs in case it is used for dancing. However, David Dillon writes, "Not everything sings. The gray brick on the exterior is too dark, and when continued inside produces a somber, prisonlike feel"(Dillon, n.d.). Brad Cloepfil, the lead designer, is reported to be disappointed that students have not engaged the architecture further. He is quoted as saying "It's just a bunch of simple brick and concrete spaces that need to be personalized"(Dillon, n.d.).

The industrial, utilitarian treatment of the interior is interesting when compared to the bright, open spaces seen in other learning environments (see figure 43). This school seems less concerned with warmly welcoming students than with issuing a challenge to their creativity. Desirous to see students forcefully inscribe themselves upon and 'mess with' the hard spaces, Cloepfil opines, "[the building] can take it"(Dillon, n.d.).

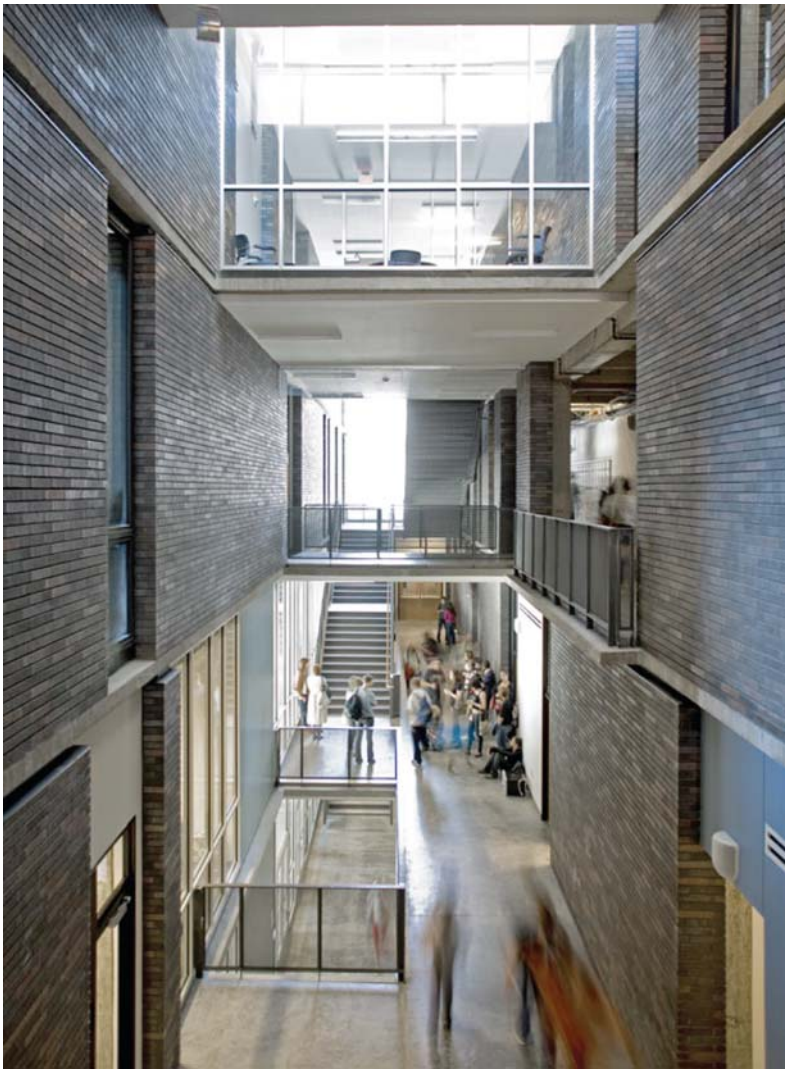

Figure 43 Interior corridor. Adapted from "Case Study: Booker T. Washington High School, Dallas, Texas, Allied Works" by D. Dillon, n.d., Retrieved from http://archrecord.construction.com/schools/09_BookerT_Washington.asp

5.2.4 Brunswick Upper School

This Connecticut school was featured in *Architectural Record* to specifically highlight an addition and renovation completed by S.O.M.

However, it was the interior images of older parts of the school that caught my eye.

In the dining area, students are seated at standard dining tables in standard dining chairs. Similar to those you might find in a home, they are neither plastic nor attached to the table itself. They immediately bring to mind intimate images of dining at home and cue the behaviors and traditions associated with those images (see figure 44).

Similarly, the English classroom features a rather large traditional dining room table, also equipped with wooden dining chairs. The large windows are double hung with small traditional panes typical of a home, and the floor is dotted with area rugs. The cues are non-institutional. The space has been claimed. The room feels lived in, and orients the user to a warm intimate environment fit for conversation (see figure 44).

Figure 44 Dining area (left) and English classroom (right). Adapted from "Brunswick High School." Retrieved from http://archrecord.construction.com/projects/bts/archives/k-12/09_Brunswick/default.asp?bts=k12

5.2.5 Concordia International School

Located in Shanghai and designed by Perkins Eastman, this school prioritizes connection to the outdoors and to variable learning spaces. Classrooms are partially shared and the commons is outfitted to become viable teaching space (see figure 45). Extensive glazing and rooftop terraces serve to connect the users to natural light and open-air environments (see figure 46).

Figure 45 First floor plan. Adapted from "Making Connections: Despite Space and Budget Constraints, Concordia International School Shanghai Embraces a Community Feeling" by J. Murdock, n.d., Retrieved from http://archrecord.construction.com/schools/08_Concordia_International.asp

Figure 46 Interior (left and right) and terrace (center) images demonstrating connections with light and air. Adapted from "Making Connections: Despite Space and Budget Constraints, Concordia International School Shanghai Embraces a Community Feeling" by J. Murdock, n.d., Retrieved from http://archrecord.construction.com/schools/08_Concordia_International.asp

5.2.6 Denver School of Science and Technology

Designed by klipp, the building is meant to focus students on the pleasures of going to school and of engaging the sciences. Joann Gonchar (n.d.) describes the environment as having a "warm, almost domestic feel". The feeling is enhanced by the use of warm colors, carpeting, and places in the corridor that feature soft furnishings for socializing or studying. The Head of the School reports low incidence of vandalism and attributes it to the building design, stating, "'Great school cultures take care of buildings, and great buildings take care of school cultures"(Gonchar, n.d.)

Figure 47 Corridors featuring carpeting, warm colors, and soft furnishings. Adapted from "A Learning Community: Dynamic and Adaptable Spaces Serve Hands-On Education at a Charter School with a Science, Math, and Technology Forums" by J. Gonchar, n.d., Retrieved from http://archrecord.construction.com/schools/0701_CS4_Denver-2.asp

5.2.7 Jeremiah E. Burke High School

This high school was chosen primarily because of its unique connection to the community surrounding it. Many high schools orient parts of the building for secure after-hours use by members of the public, but few attempt to blend an additional truly public project into the school. On the first floor, Schwartz/Silver Architects incorporated a branch of the public library, which connects to the school library. The two operate as separate facilities during school hours, but merge into one after school (Brooms, B.). This move lends credibility to the oft-referenced idea of the school as a point of community pride and center of lifelong learning.

Figure 48 Public program highlighted on the section provided by Schwarz/Silver Architects. Adapted from "Case Study: Jeremiah E. Burke High School, Boston, Massachusetts, Schwarz/Silver Architects" by B. Brooms, n.d., Retrieved from http://archrecord.construction.com/schools/09_Burke_High.asp

Figure 49 Interior spaces showing warm wood flooring, colorful glass overlays, colorful soft furnishings, and pendant lighting. Adapted from "Case Study: Jeremiah E. Burke High School, Boston, Massachusetts, Schwarz/Silver Architects" by B. Brooms, n.d., retrieved from http://archrecord.construction.com/schools/09_Burke_High.asp

5.2.8 Oslo International School

The Oslo International School is a unique example combining modular construction with curvilinear form, bold colors and warm interiors, and the incorporation of multiple courtyard spaces. The classrooms and

corridors are kept at a smaller scale. The lighting is accentuated and used as a design element with profiles more akin to domestic spaces than institutional ones. The walls are primarily wood paneling, which even when painted adds texture to the room. The flooring is a bold warm color that anchors the space, permitting the walls and ceiling to be more neutral without overly cooling the area psychologically (see figure 52).

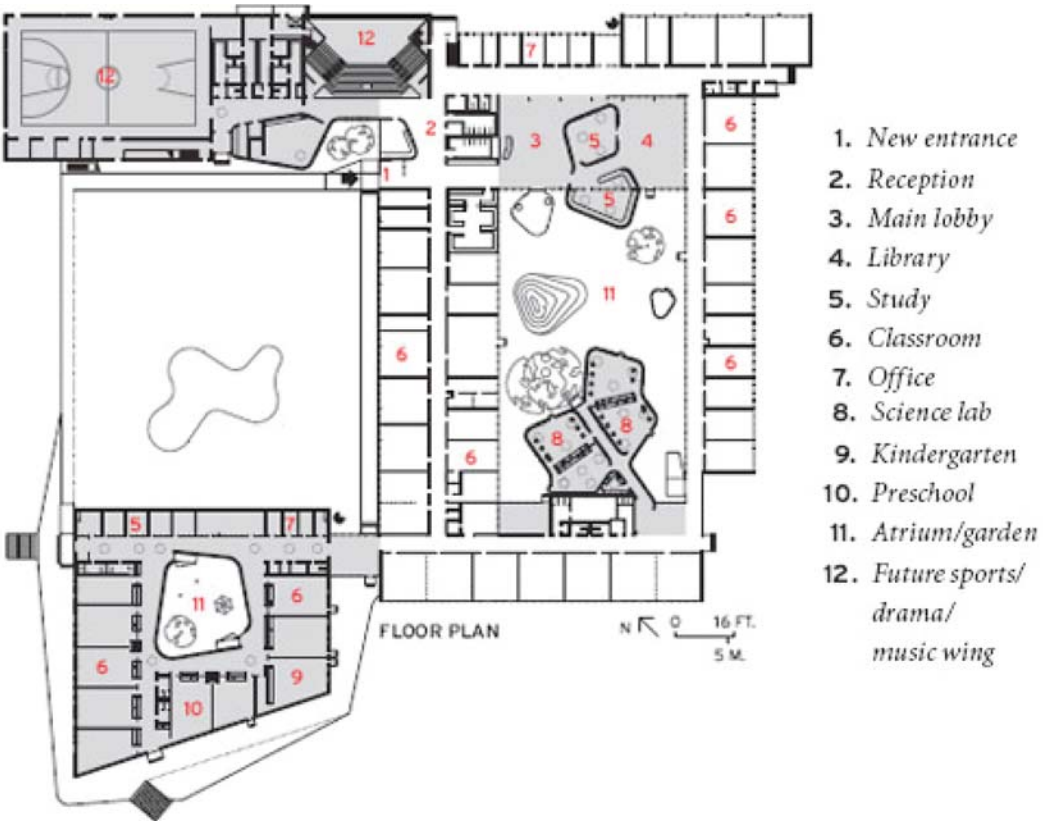

Figure 50 Floor plan of Oslo International School drawn by Jarmund/Vigsnæs Architects. Adapted from "Oslo International School: Jarmund/Vigsnæs Architects Transforms a Worm 1960's Era School Building into a Vibrant Learning Environment" by P. MacKeith, n.d.,retrieved from http://archrecord.construction.com/projects/bts/archives/k-12/09_Oslo/default.asp?bts=k12

Figure 51 Science labs occupy the courtyard and bold colors are used on the exterior. Adapted from "Oslo International School: Jarmund/Vigsnæs Architects Transforms a Worm 1960's Era School Building into a Vibrant Learning Environment" by P. MacKeith, n.d.,retrieved from http://archrecord.construction.com/projects/bts/archives/k-12/09_Oslo/default.asp?bts=k12

Figure 52 Classroom interior. Adapted from "Oslo International School: Jarmund/Vigsnæs Architects Transforms a Worm 1960's Era School Building into a Vibrant Learning Environment" by P. MacKeith, n.d.,retrieved from http://archrecord.construction.com/projects/bts/archives/k-12/09_Oslo/default.asp?bts=k12

CHAPTER 6
THE DESIGN PROGRAM AND SITE

6.1 SMALL LEARNING COMMUNITIES (SLC's)

As mentioned earlier, the research on smaller schools has yielded positive results indicating decreases in disruptive behavior, increases in student attendance, and higher graduation rates (USDOE, 2011). This is generally thought to be attributable to the stronger relationships that are possible in small school environments. The U.S. Department of Education describes SLC's as schools where "small groups of students remain together throughout high school" as well as places that provide "personalization strategies, such as student advisories, family advocate systems, and mentoring programs"(USDOE, 2011).

Size is key to the argument. Research has found that when school populations are larger than 500 students it is no longer possible for staff to know each student by name, and beyond 1,000 students, staff can no longer even recognize the faces of those in the school (Architectural League & PEA, 1992). Small size ensures that students are known. Many students in small schools report that they enjoy knowing the other students in school, and more importantly enjoy being known, even if that means being held to a greater level of accountability (Hartmann, Raumann-Moore, Evans, Haxton, Maluk, & Neild, 2009).

Therrell High School is divided into three small learning communities, with each hosting approximately 400 students. It effectively operates as three separate high schools each organized around a different theme and each governed by a separate administration, although some facilities are shared. By maximizing student connection to staff, creating more personalized learning experiences, and focusing students upon the opportunities post-graduation, it is hoped that student performance, attendance, and graduation rates will rise.

6.2 THE PROGRAM

By examining the current school, design proposals, and the Georgia Department of Education's website, a building program was developed (see figure 95 in the appendix). The program, with minimum square footages, describes the necessary elements typical of a standard large high school, and the required elements of the individual thematic spaces as well.

6.3 THE SITE

Therrell High School is located in southwest Atlanta, in an area called East Point. Although it is decidedly within the city's perimeter, the location has a suburban, if not rural, feel. It is surrounded primarily by single-family dwellings that are one story in height and located on

wooded lots. The site itself has over one hundred feet of rise in topography from +900' to +1015'.

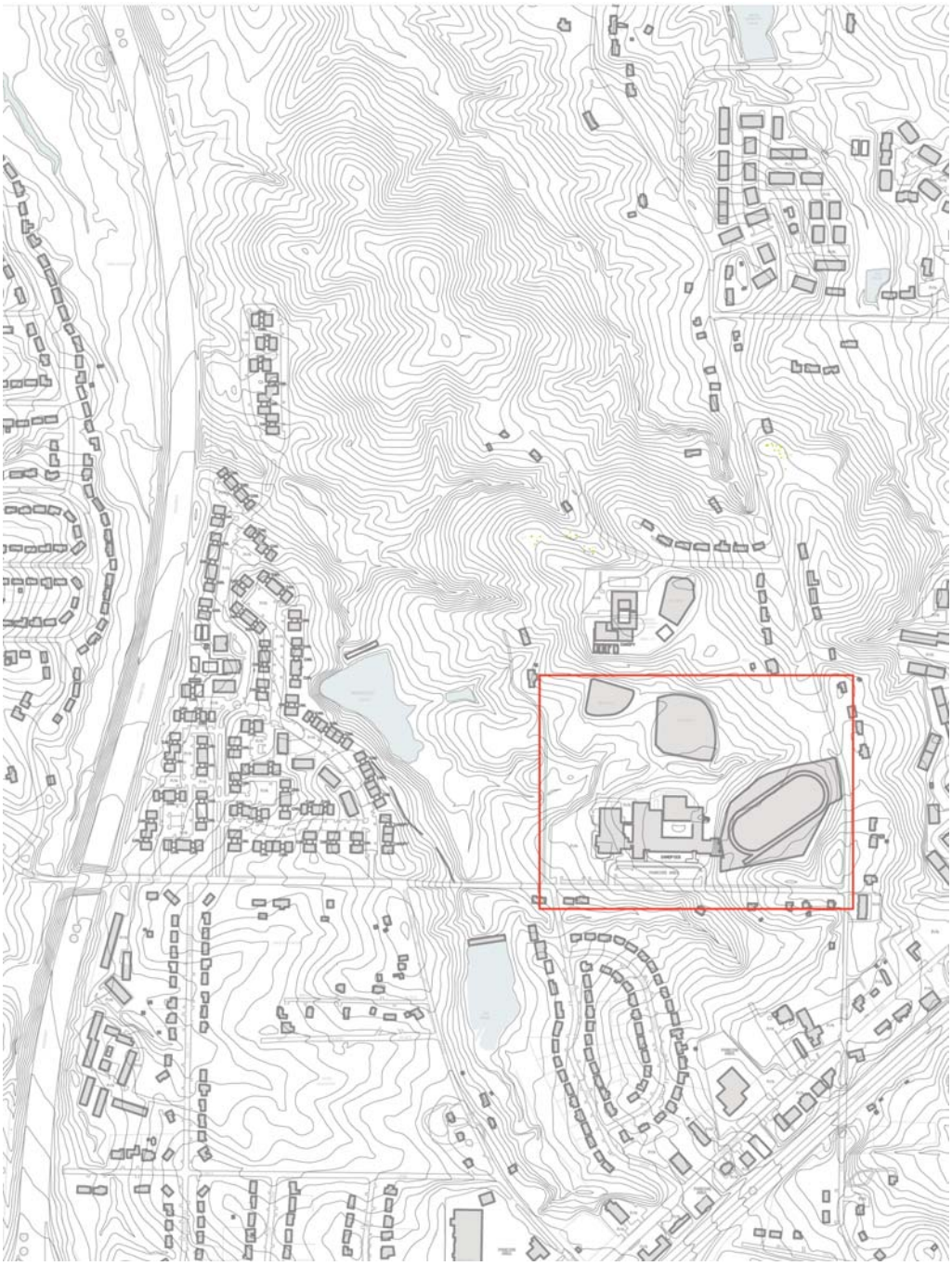

Figure 53 Area plan. Therrell High School and it's site in the current condition are highlighted. Drawing adapted from Atlanta Area Plan provided by the Imagine Lab, Georgia Tech, 2010.

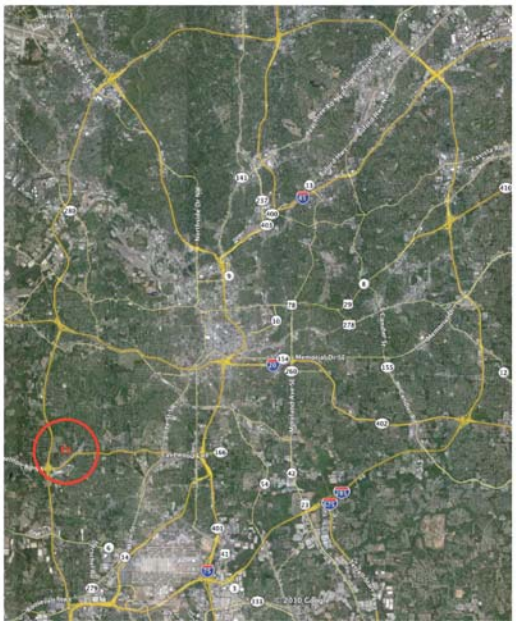

Figure 54 Satellite image showing the Therrell site situated inside the city's perimeter. Adapted from Google Earth, 2010.

Figure 55 Views on the roads directly adjacent to the site. Adapted from Ian Reves, 2010.

Figure 56 Satellite image showing the site. Adapted from Google Earth, 2010.

The site benefits from full sun and also from the surrounding trees, which create attractive views and a warm, secluded environment.

PART 3

SCHEMATIC DESIGN

CHAPTER 7
SCHEMATIC DESIGN: FORMAL INVESTIGATIONS

7.1 THE CLASSROOM UNIT

Schematic design began by examining the most important programmatic piece: the classroom. In addition to being the most basic element, it constitutes the largest square footage, being the most repeated unit.

A primary imperative for the classroom design was the desired variability. While a great deal of learning takes place in the standard lecture format, which engages a whole group, many educational activities are taught in small group or one-on-one format. Frequently students are pulled out for tutoring, or asked to complete alternate activities in order to meet individualized educational goals. Therefore, three types of learning spaces were deemed necessary: a large classroom space, a small group workspace, and a space for individual study. The large classroom becomes the hub with the other spaces must accessible from it; the small group space would ideally be accessible from the corridor as well.

Providing variations in the learning environments not only supports differences in learning modalities, but also allows students to exercise preference in determining their environment. This may support better learning outcomes consistent with Ertel's findings (1973 cited in Brebner

1982, p 162) in which students who were tested in preferred environments scored higher, as well as Killeen, Evans, and Danko's (2003) findings that a student's sense of control over the learning environment supports learning outcomes.

Once the types of spaces were determined, attention turned to the actual sizes required to fulfill the stated purposes, and more detailed space plans were executed in order to determine the viability of the designs. Multiple initial small-scale classroom schemes were tested against large-scale site plans that were being developed in tandem, providing a feedback loop for progress.

Initially, the Voronoi diagram was explored. It was selected because of its inherent ability to organize variation. However, the variability proved to be too much making it difficult to regulate the spaces to the necessary level and still justify use of the pattern.

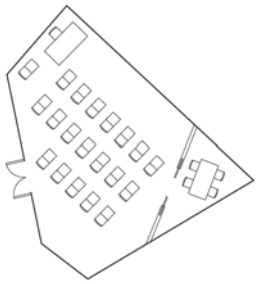

Figure 57 Classroom layout developed from the Voronoi diagram.

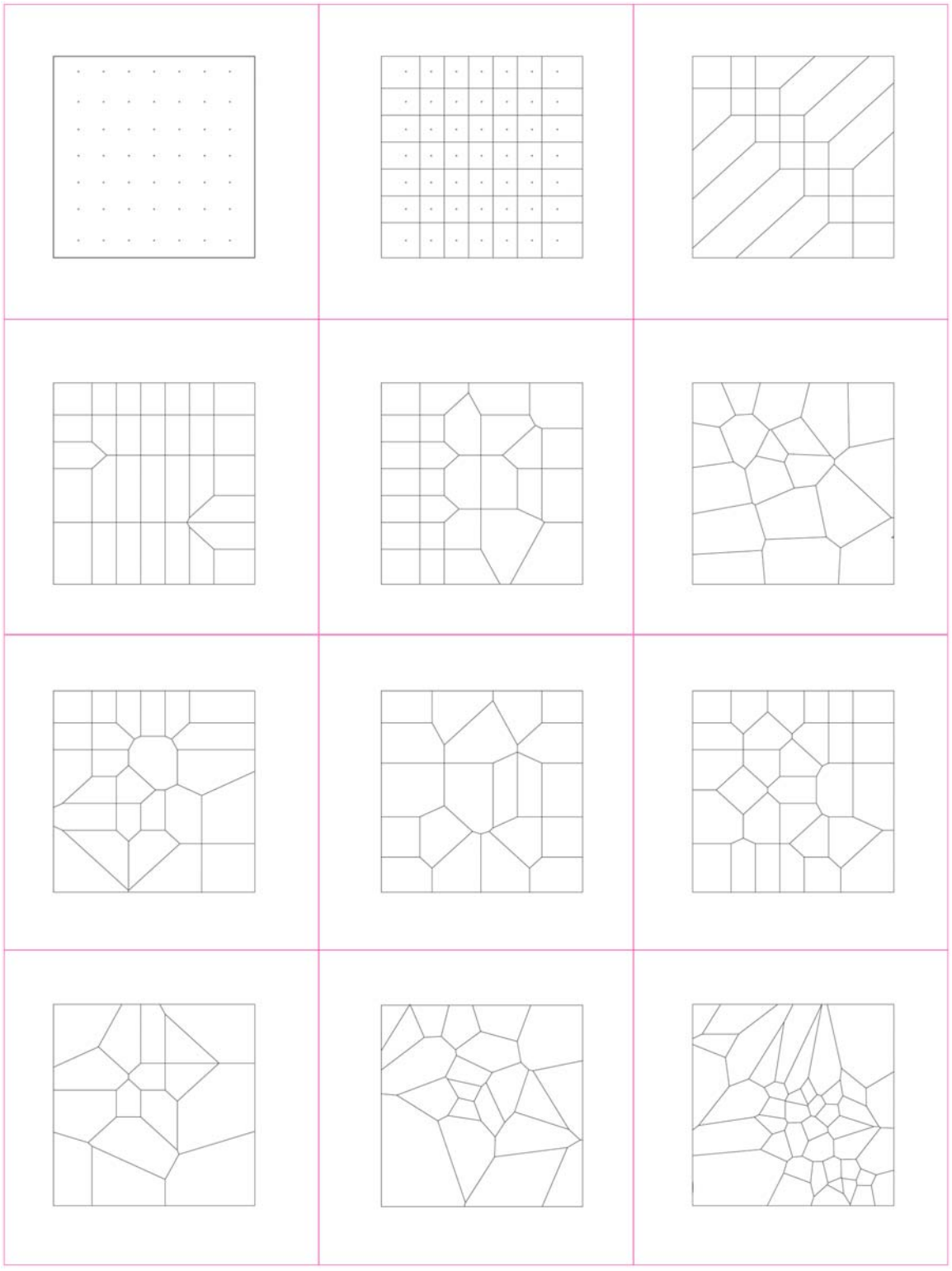

Figure 58 Organization of multiple spaces based on the Voronoi diagram.

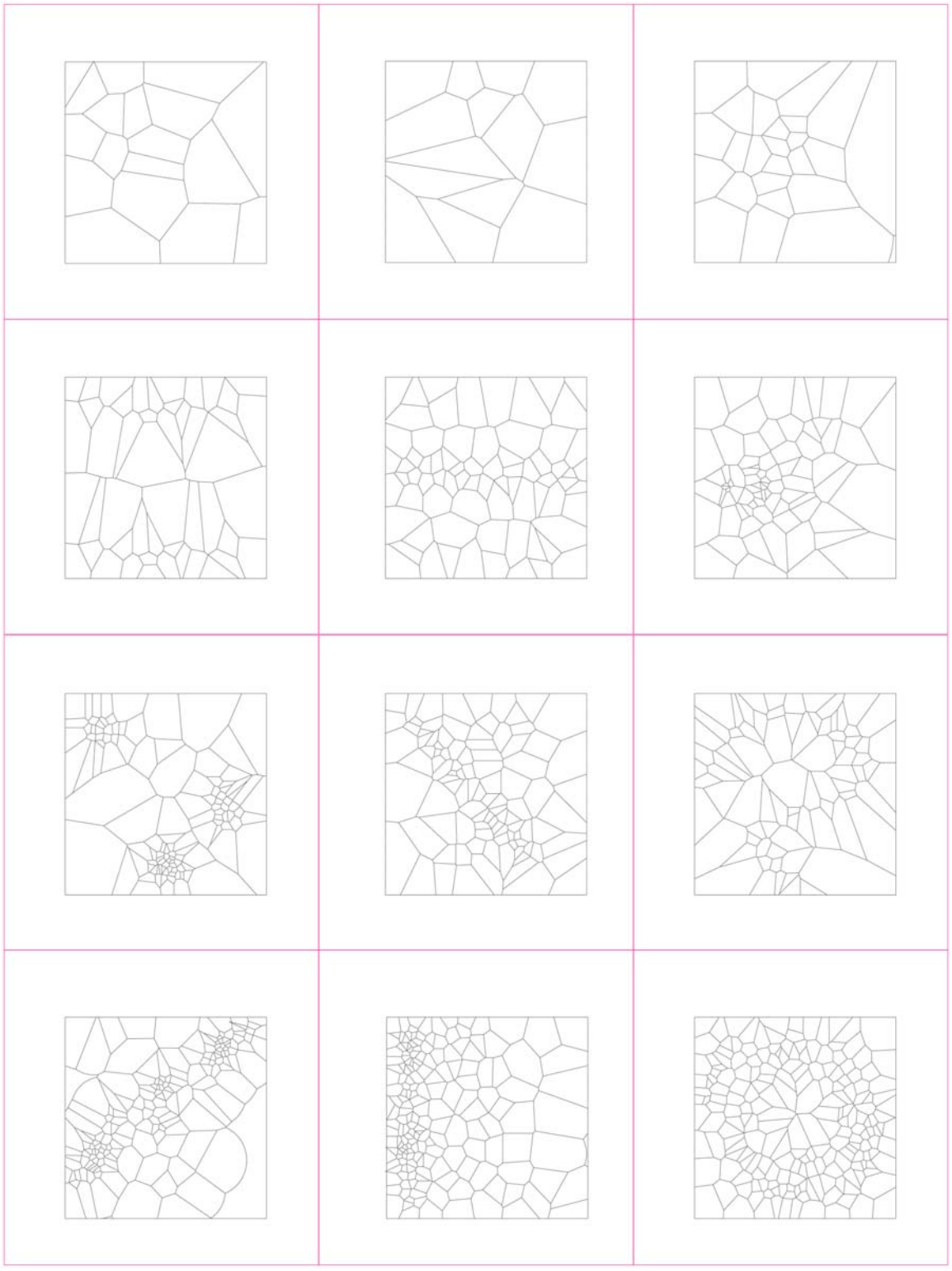

Figure 59 Organization of multiple spaces based on the Voronoi diagram.

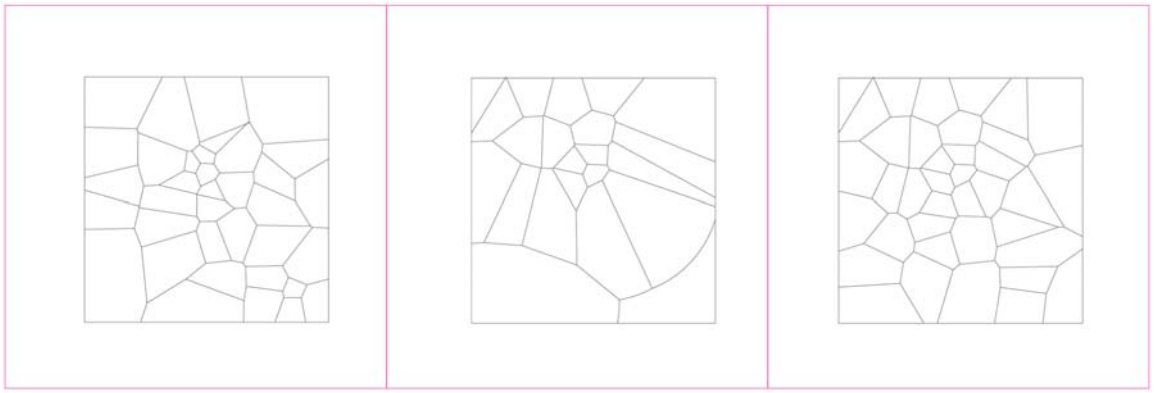

Figure 60 Organization of multiple spaces based on the Voronoi diagram.

The hexagonal shape was also investigated early on. The six sides accommodated the variable learning spaces, as well as entrances to the corridor and courtyard, and most promising, the number of sides allowed the aggregation of classrooms to create diversity in the corridors as well. While the initial variety was interesting, upon investigation the new spaces were often undesirable in character, and the resulting geometry did not readily accept larger programmatic elements. The new spaces became problematic in themselves rather than offering solutions.

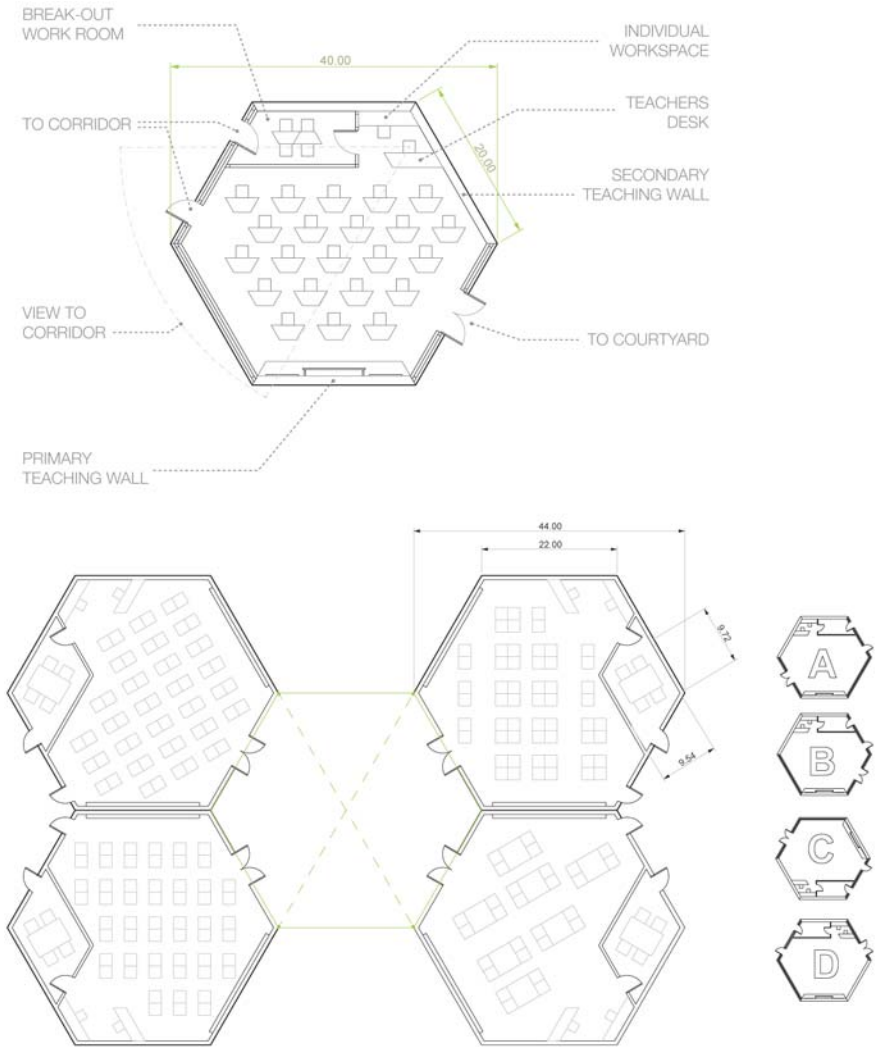

Figure 61 Hexagonal classroom layouts.

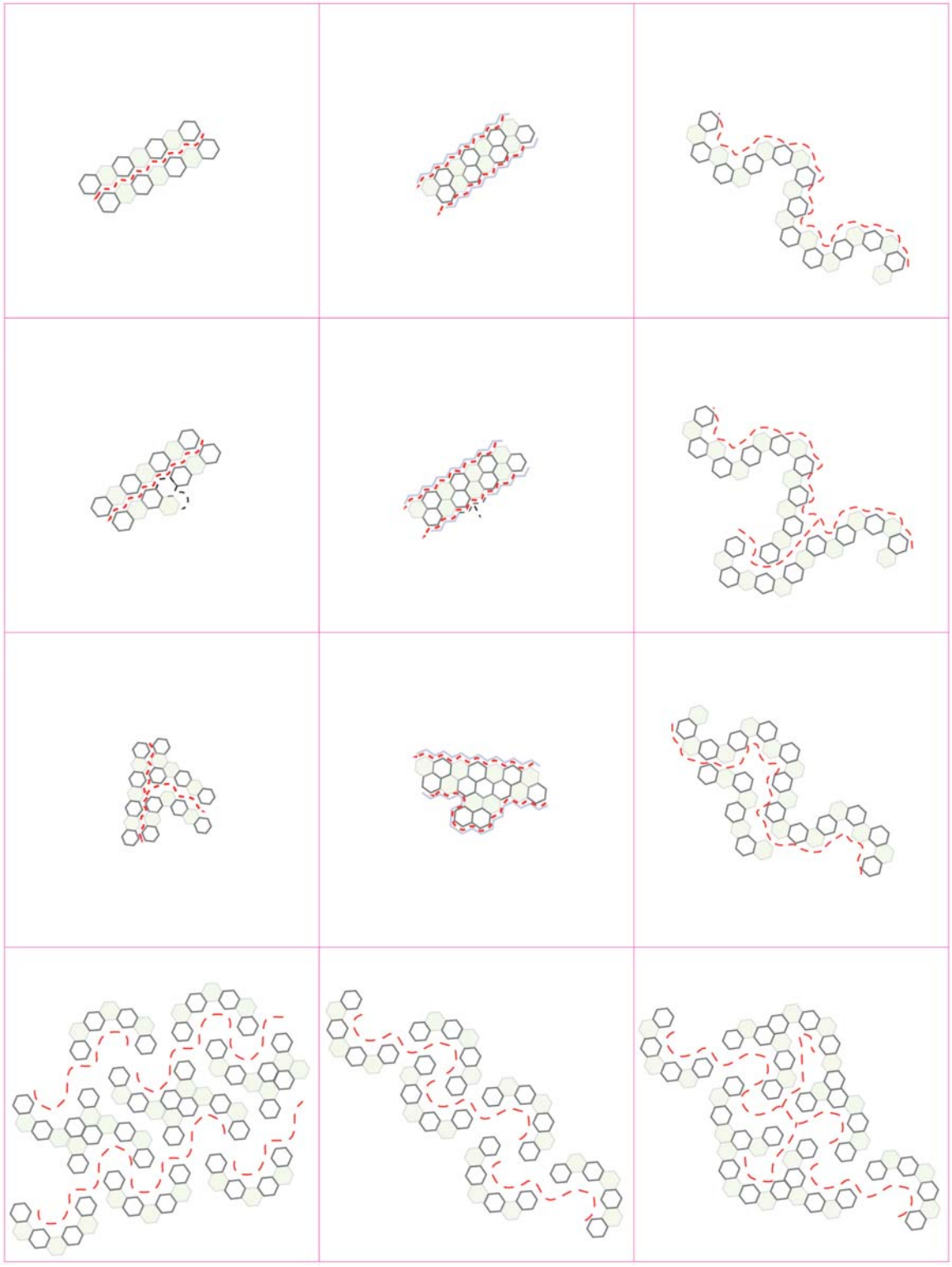

Figure 62 Investigating circulation and growth patterns of the hexagon.

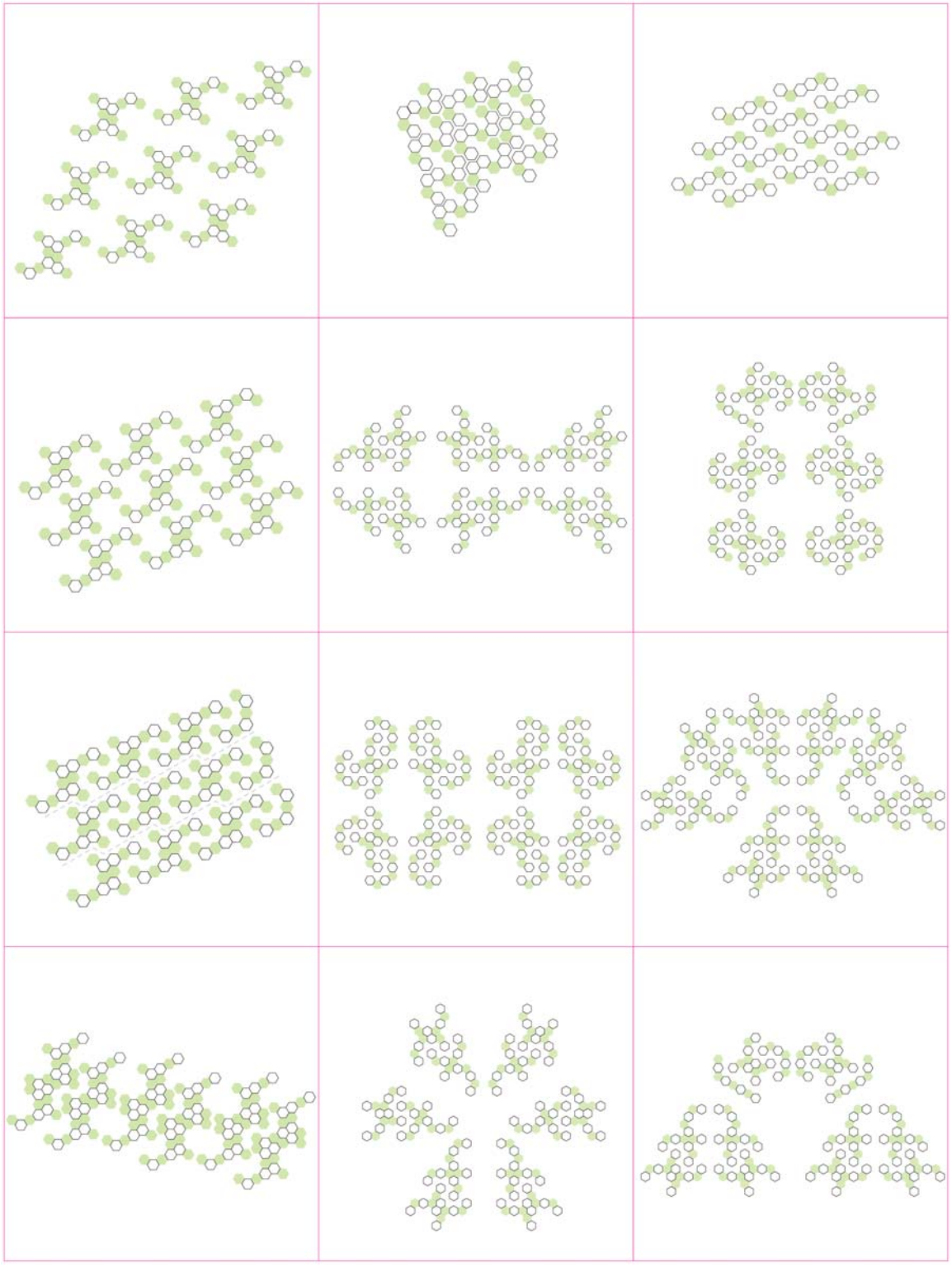

Figure 63 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

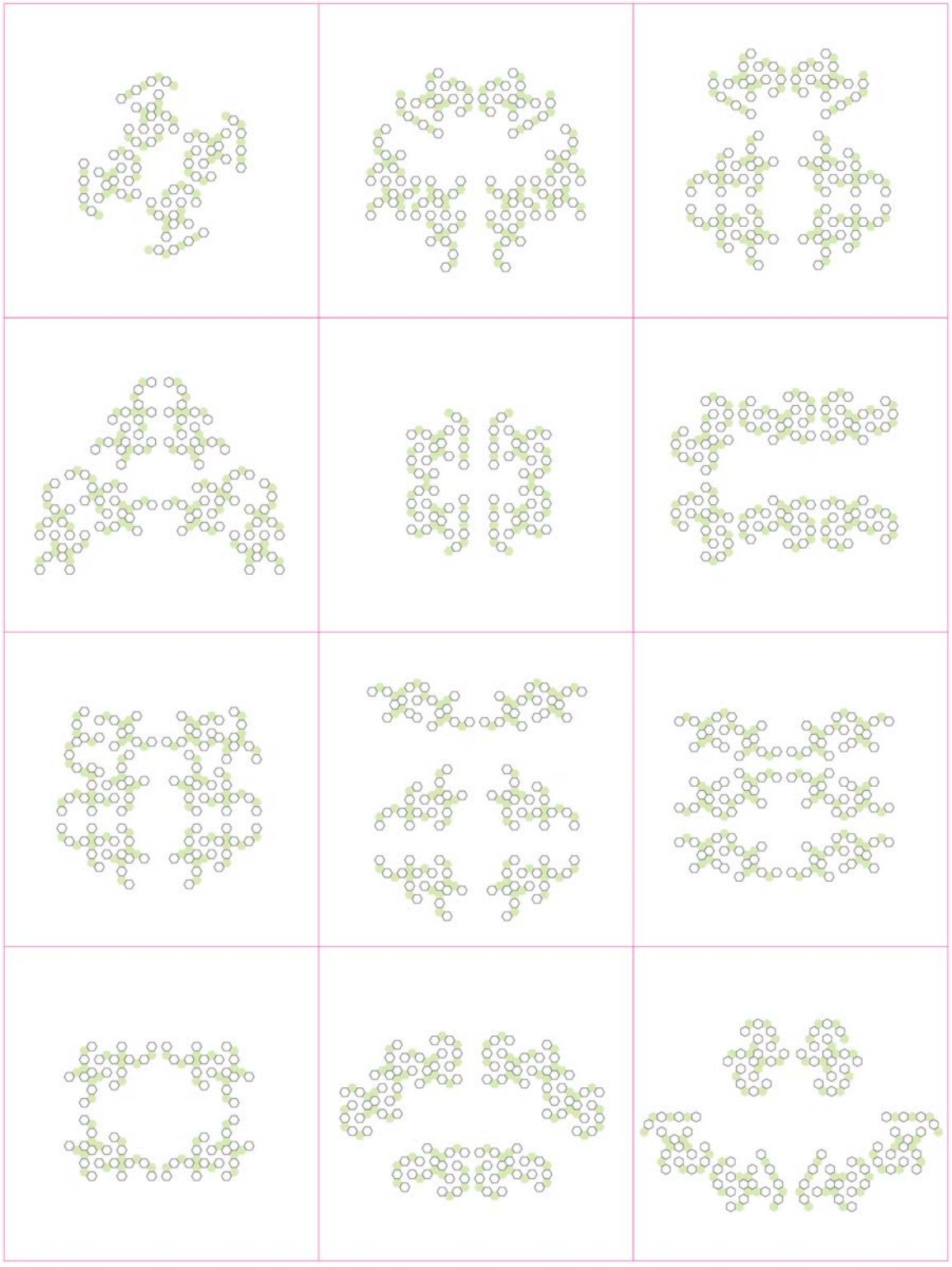

Figure 64 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

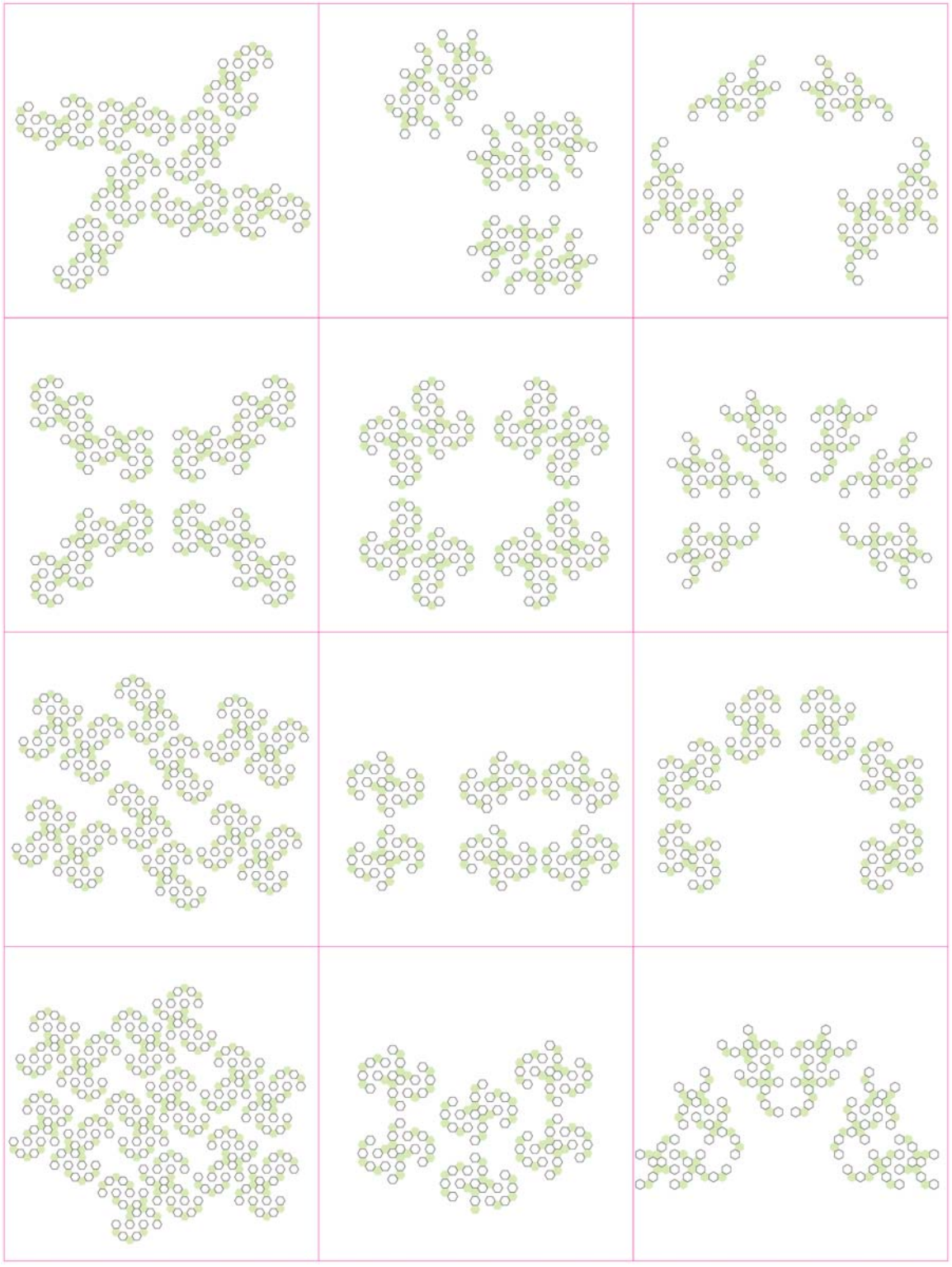

Figure 65 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

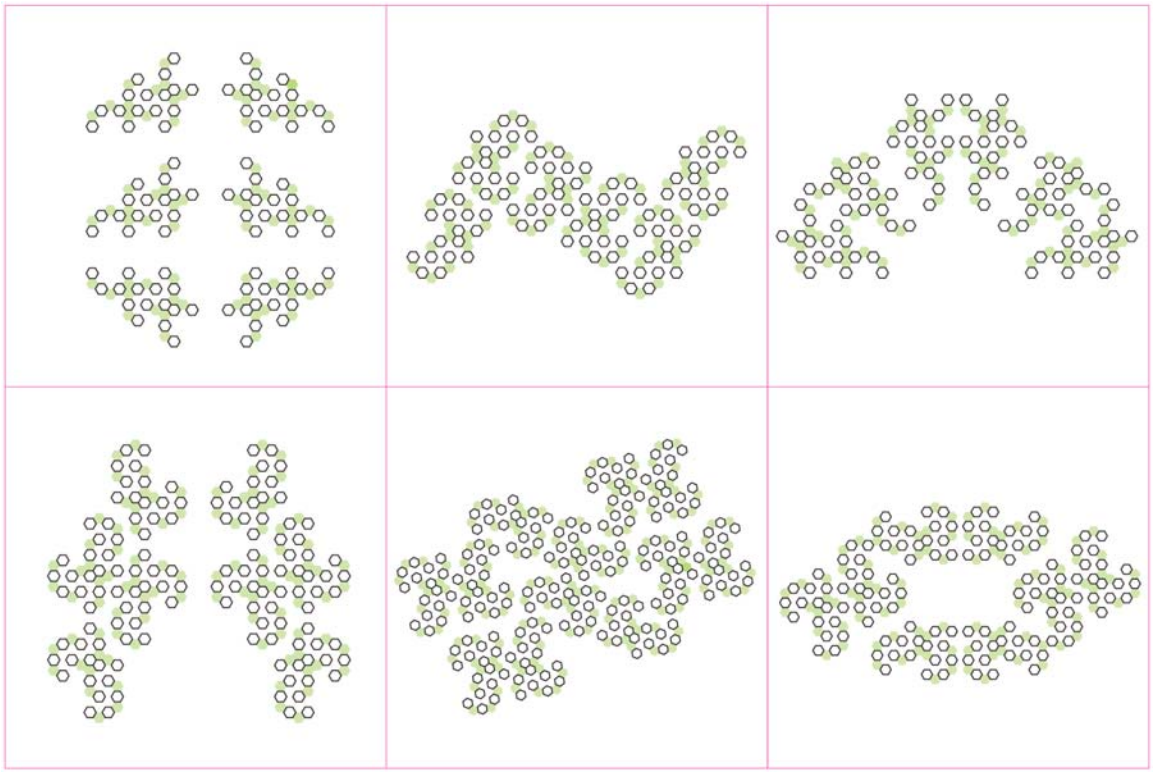

Figure 66 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

Taking cues from the results of the hexagonal study the parallelogram was pursued. It offered similar classroom benefits, and allowed for variation in the corridor, but was more easily controlled and accepting of larger programmatic elements. However, the acute angles, which provided such desirable corridor space, made the smaller learning units more awkward.

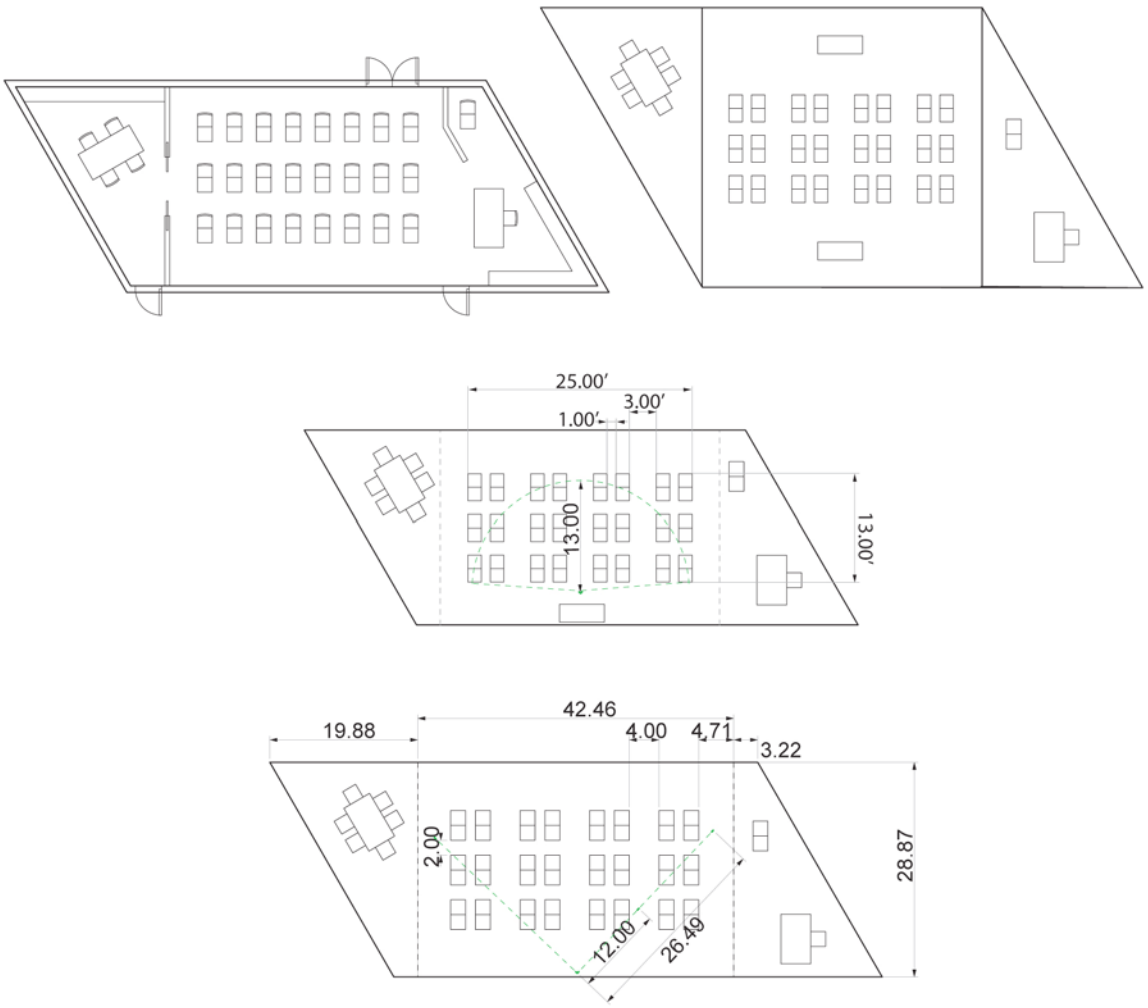

Figure 67 Classroom studies for the parallelogram.

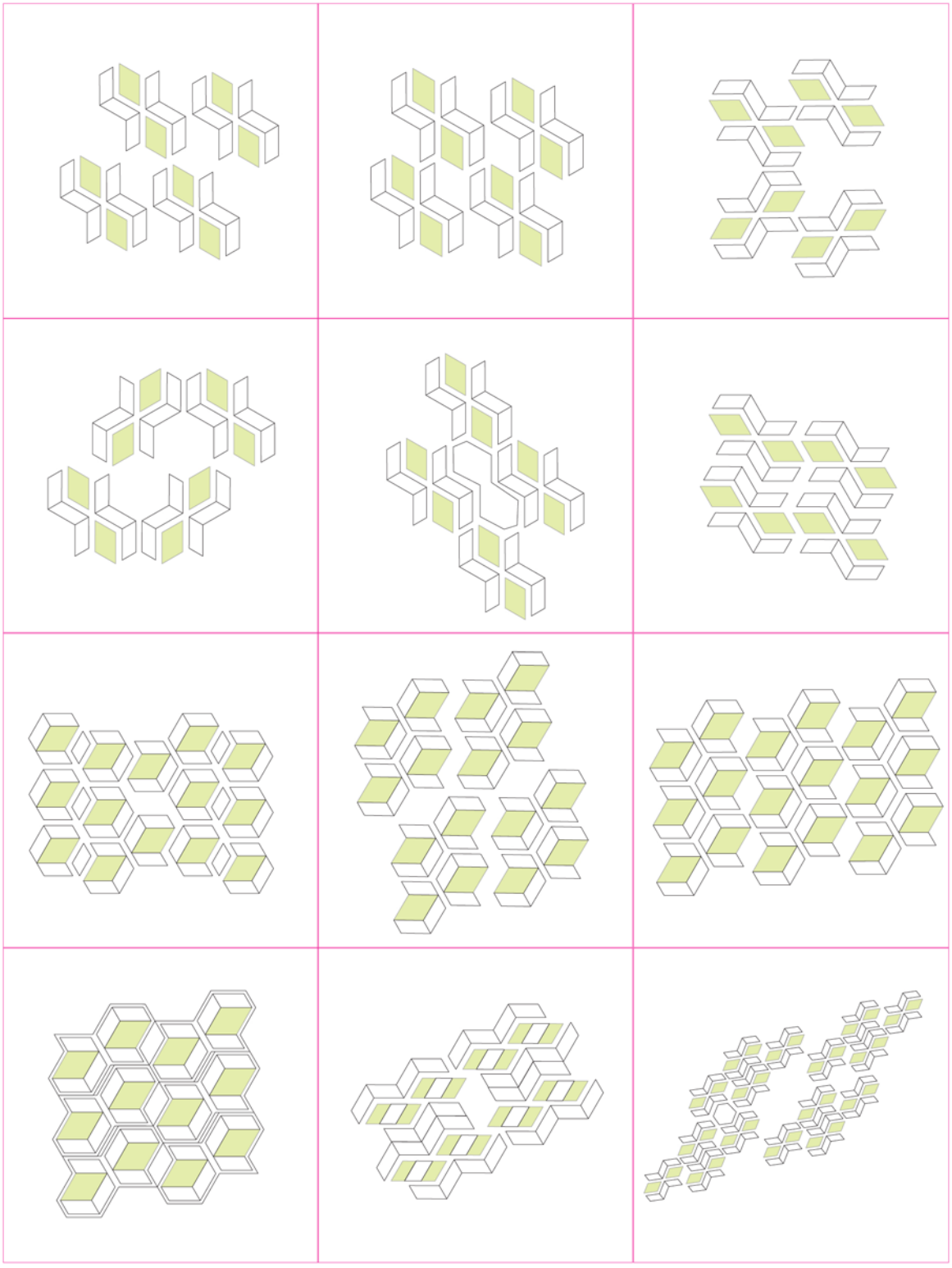

Figure 68 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

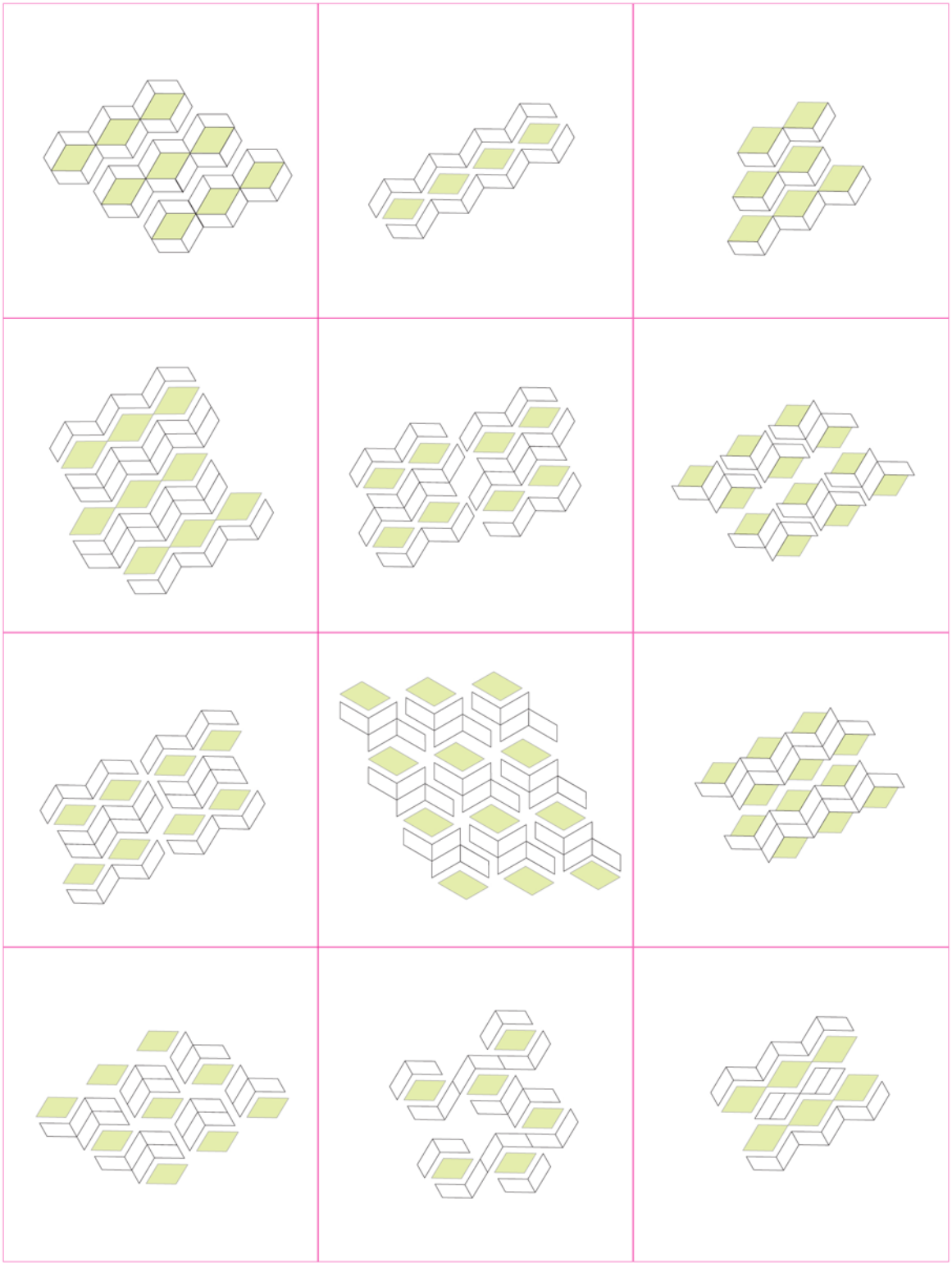

Figure 69 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

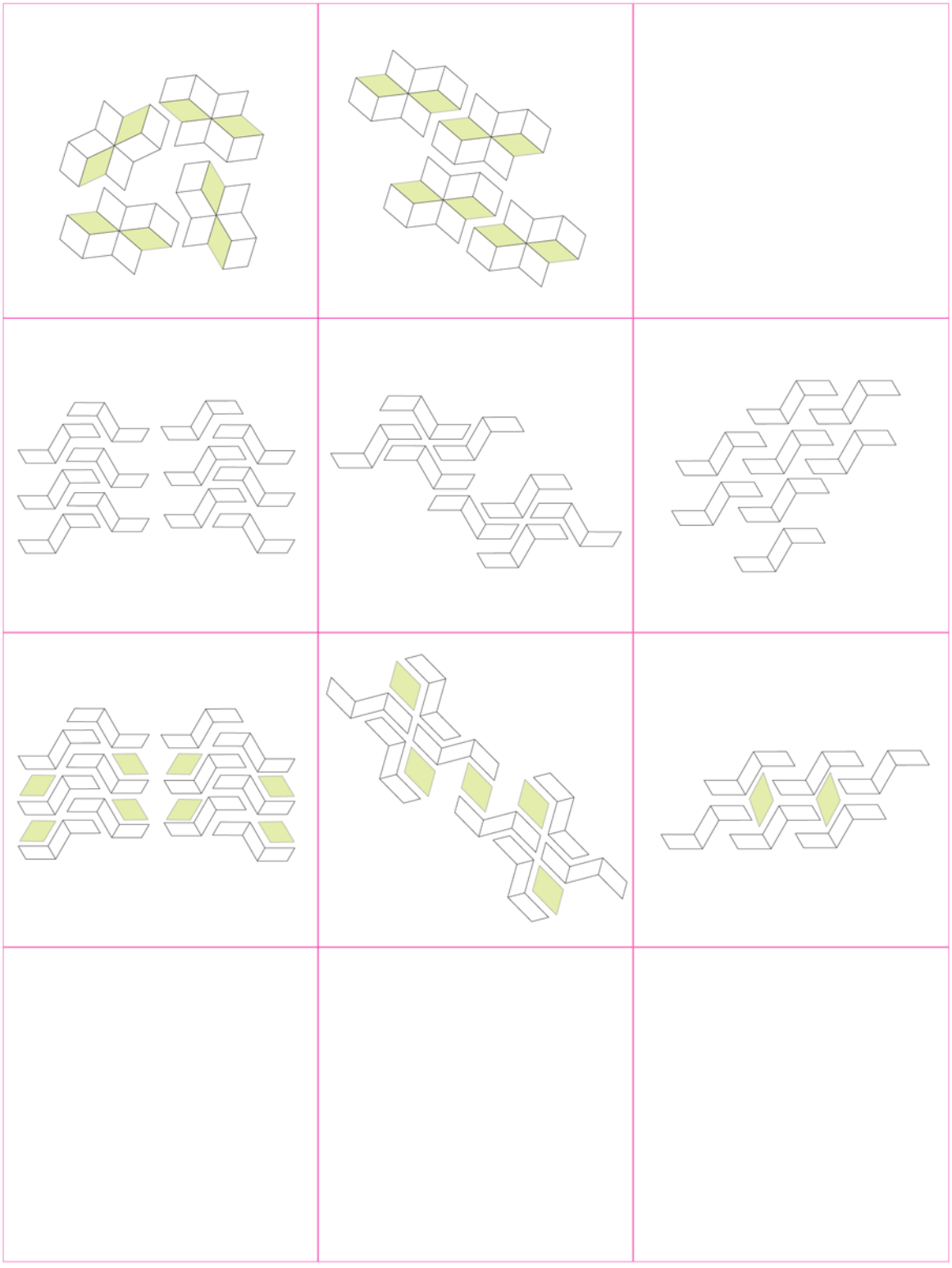

Figure 70 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

At the classroom level, many shapes were pursued and deemed viable. At the site level, however, it was understood that in order to produce the corridor space desired, the classrooms must have either non-right angles where classroom meets classroom, or an uneven number of sides. Therefore, pentagons and trapezoids were both pursued.

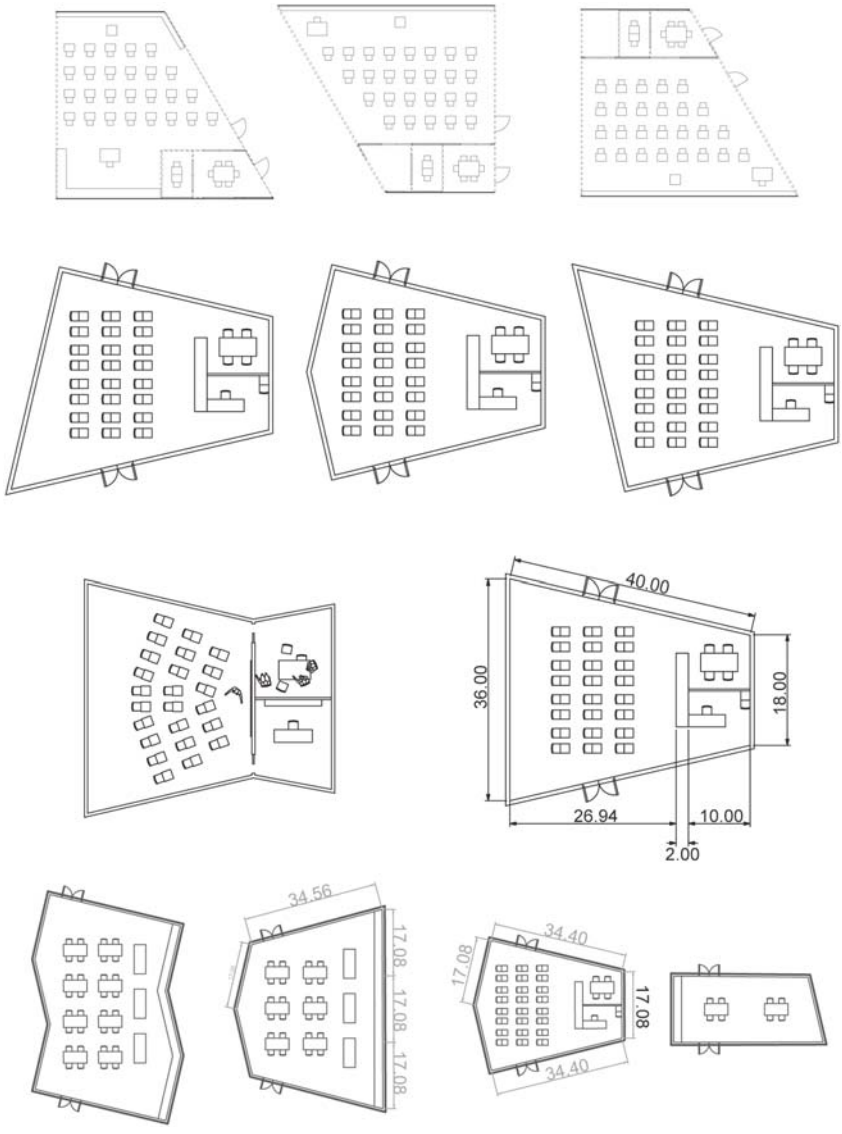

Figure 71 Classroom layouts for the trapezoid and variations.

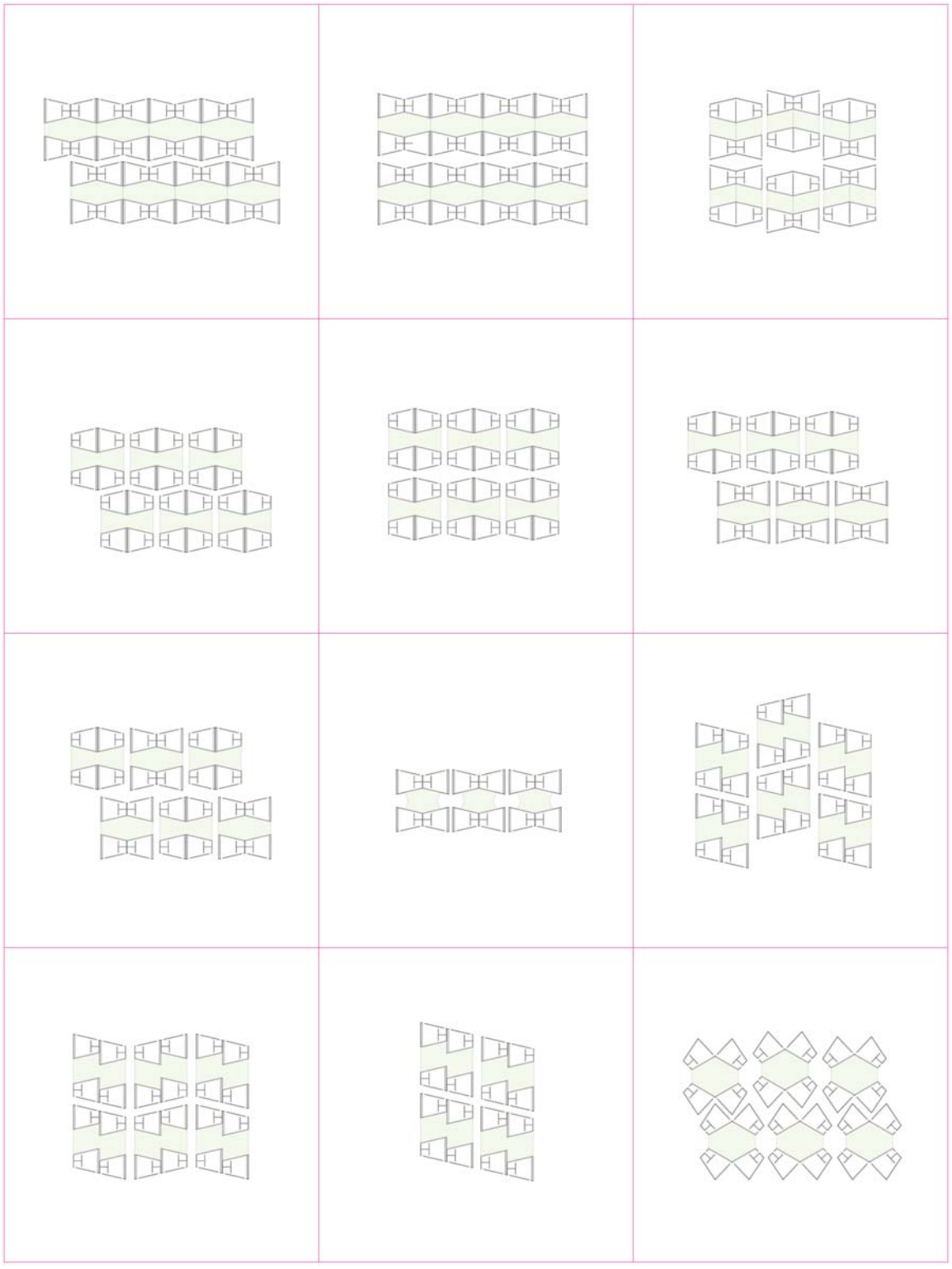

Figure 72 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

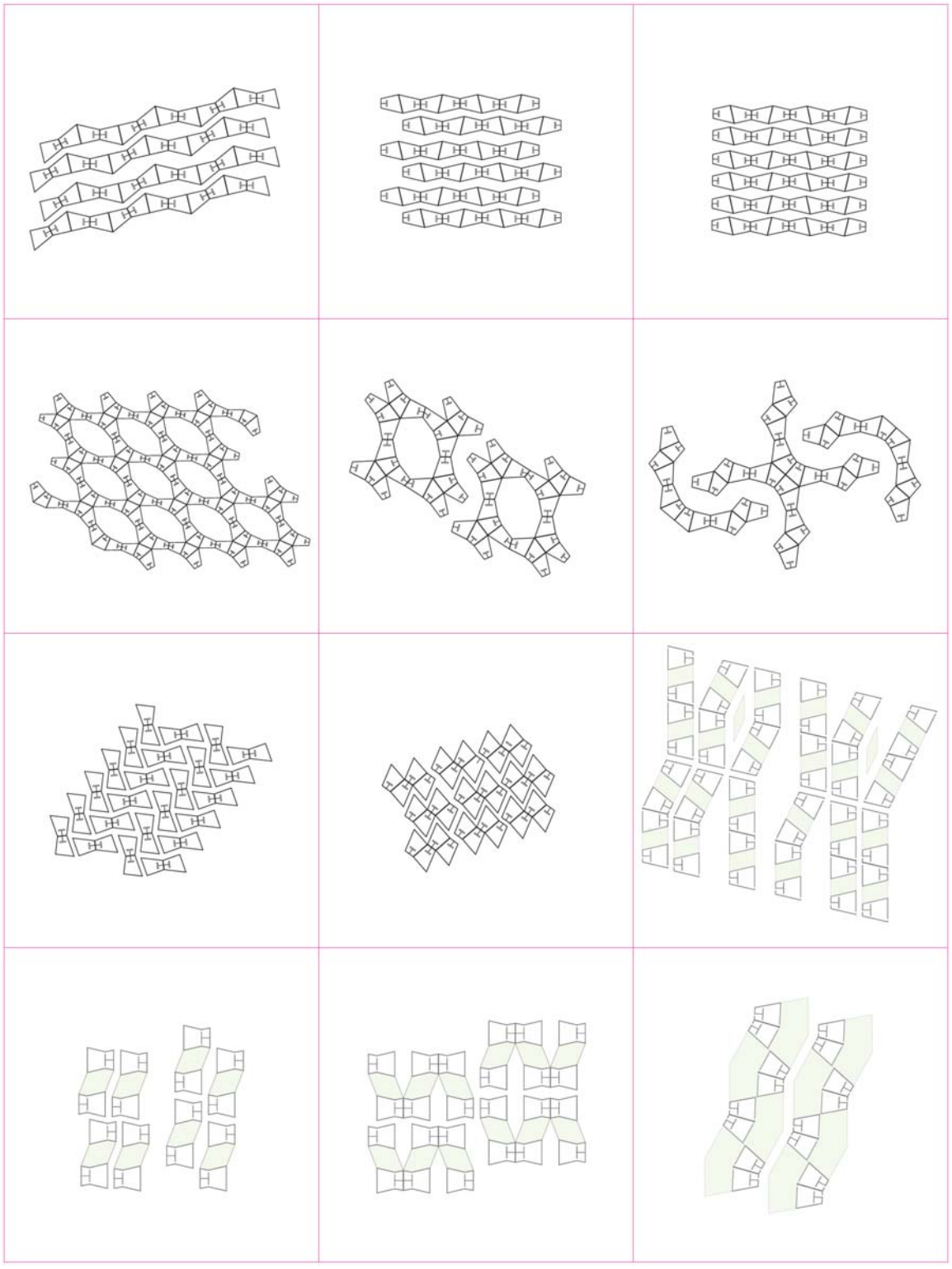

Figure 73 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

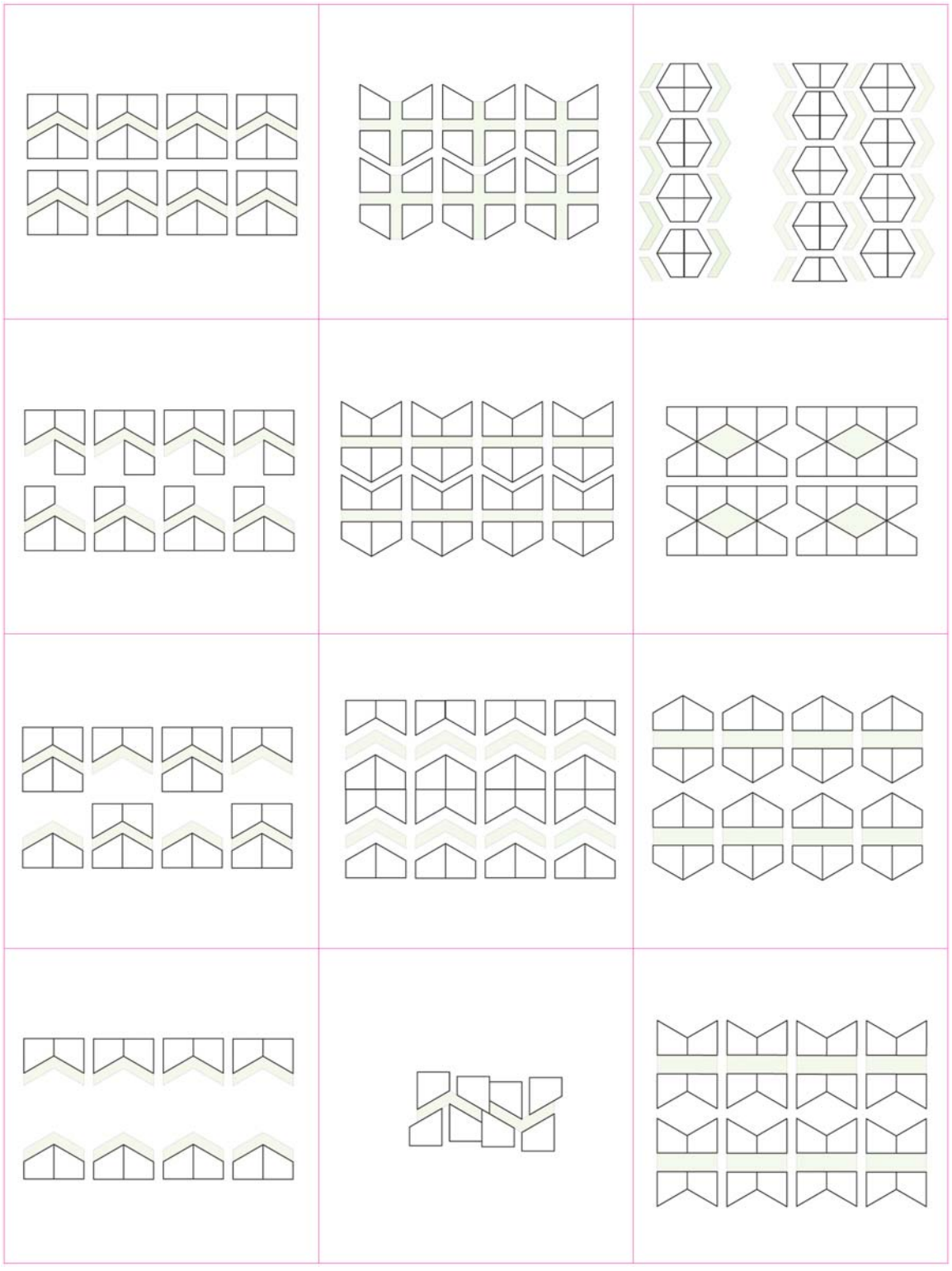

Figure 74 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

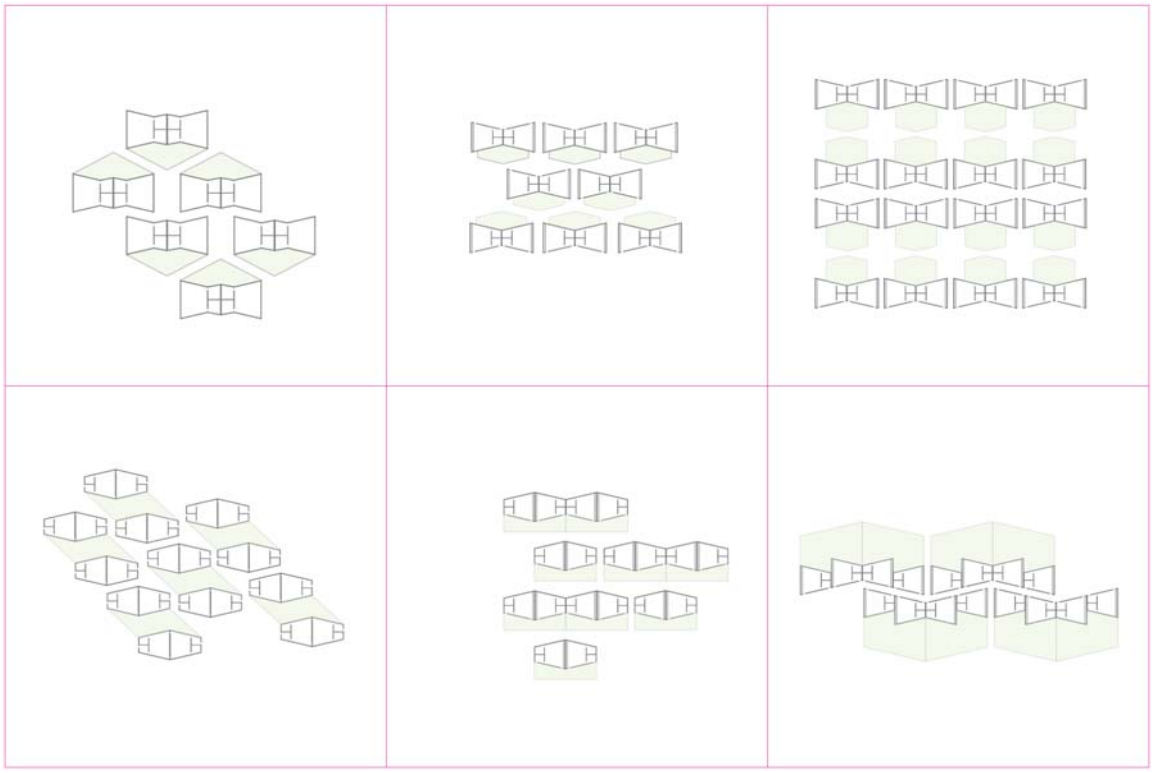

Figure 75 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

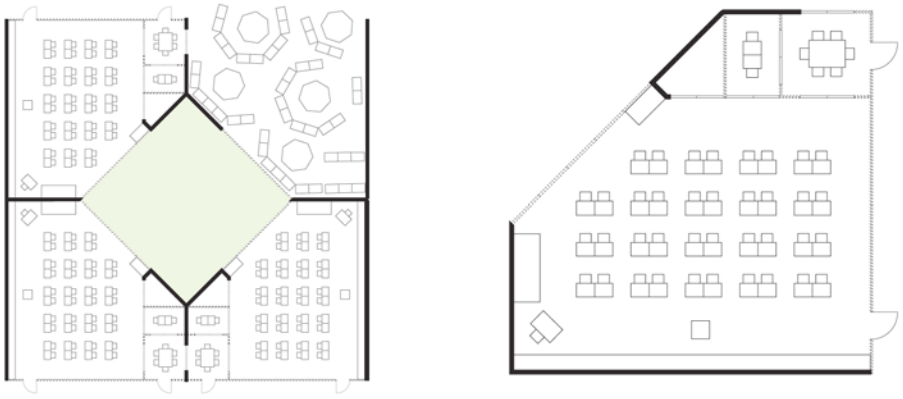

Figure 76 First design of pentagonal classroom layout.

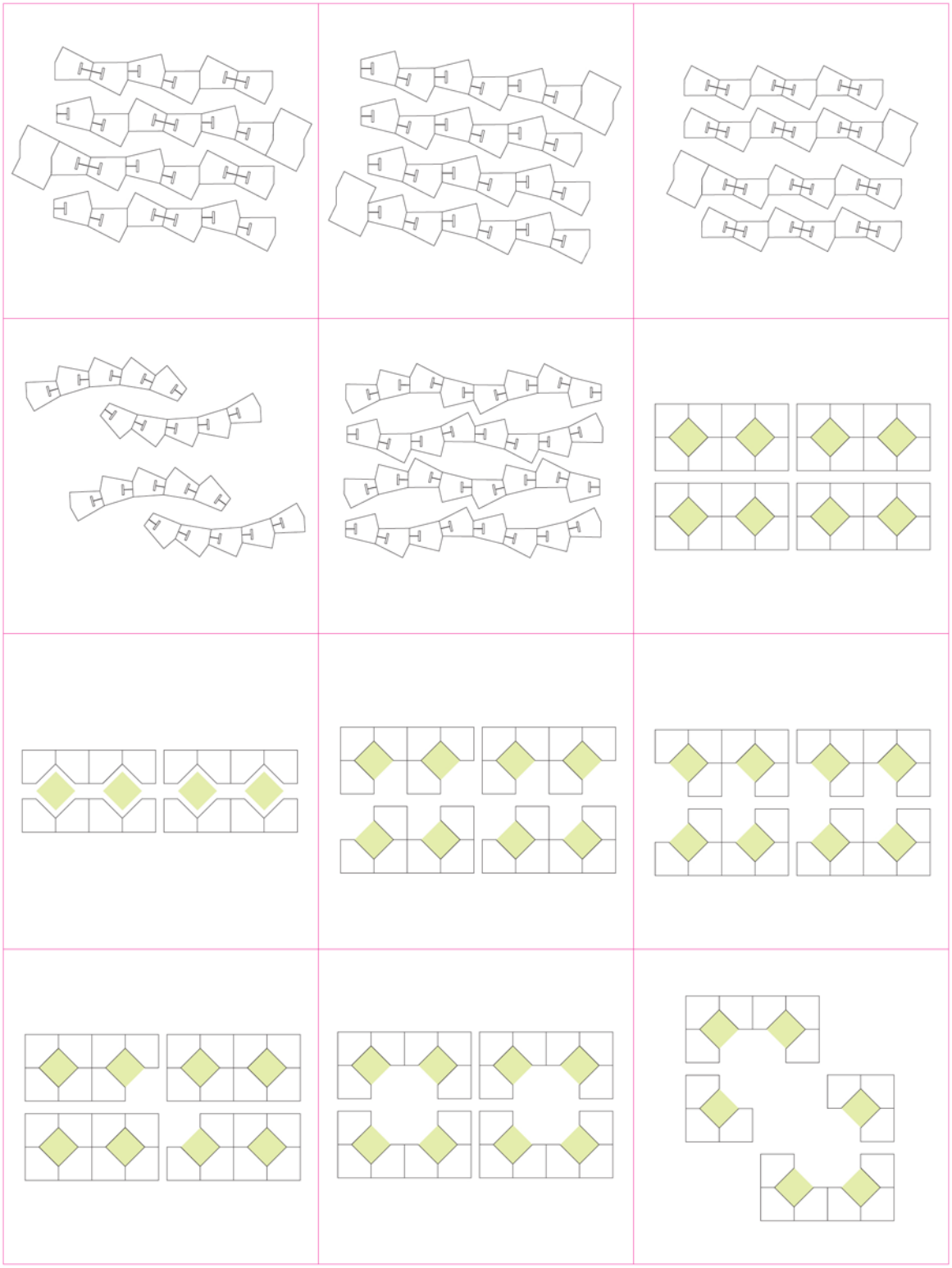

Figure 77 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

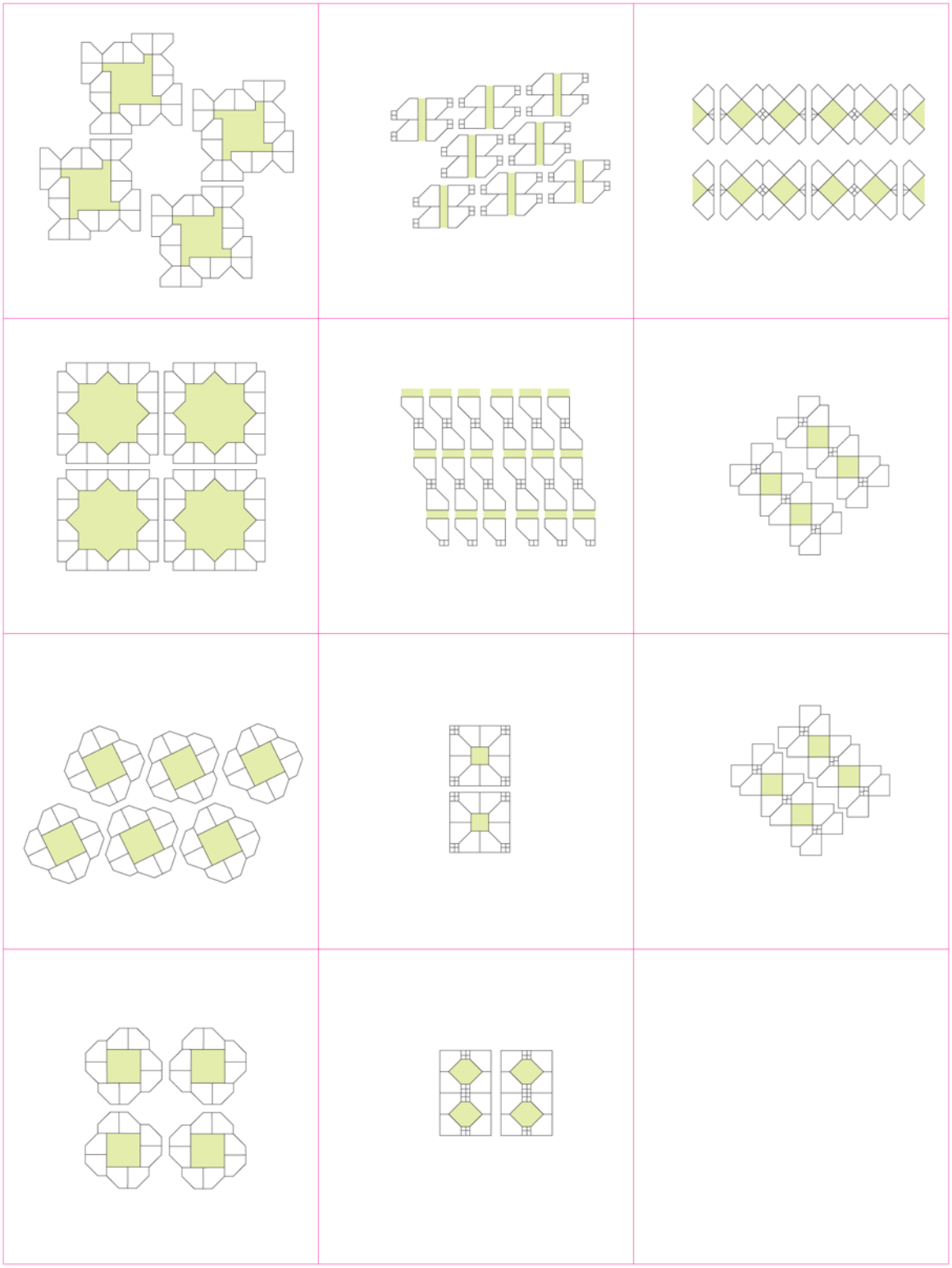

Figure 78 Organization of classrooms and courtyards. All required standard classrooms are shown in each scenario. Larger programmatic elements are omitted.

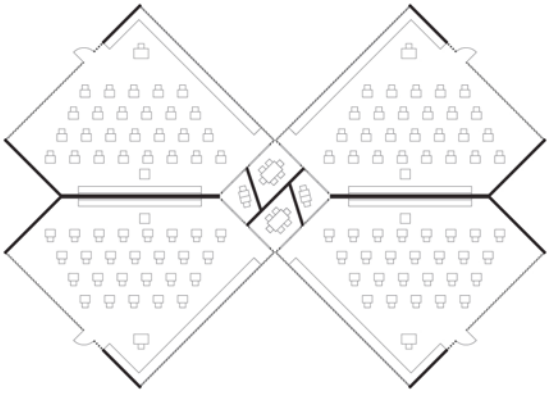

Figure 79 Second design of pentagonal classroom layout.

The pentagon showed the greatest potential upon investigation. The connections between classroom units provided for the desired corridor variation. And after shifting the teaching wall in the second design iteration, the classroom layout showed great potential as well.

In this scheme, the smaller learning spaces were shifted out of the classrooms themselves and became stand-alone, yet shared pieces, which highlighted their role as necessary learning environments in their own right within the school, and also cut down the required square footages. In the latest iteration (see figure 81) the learning spaces are enlarged enough to allow a secondary point of access giving them even greater autonomy of use.

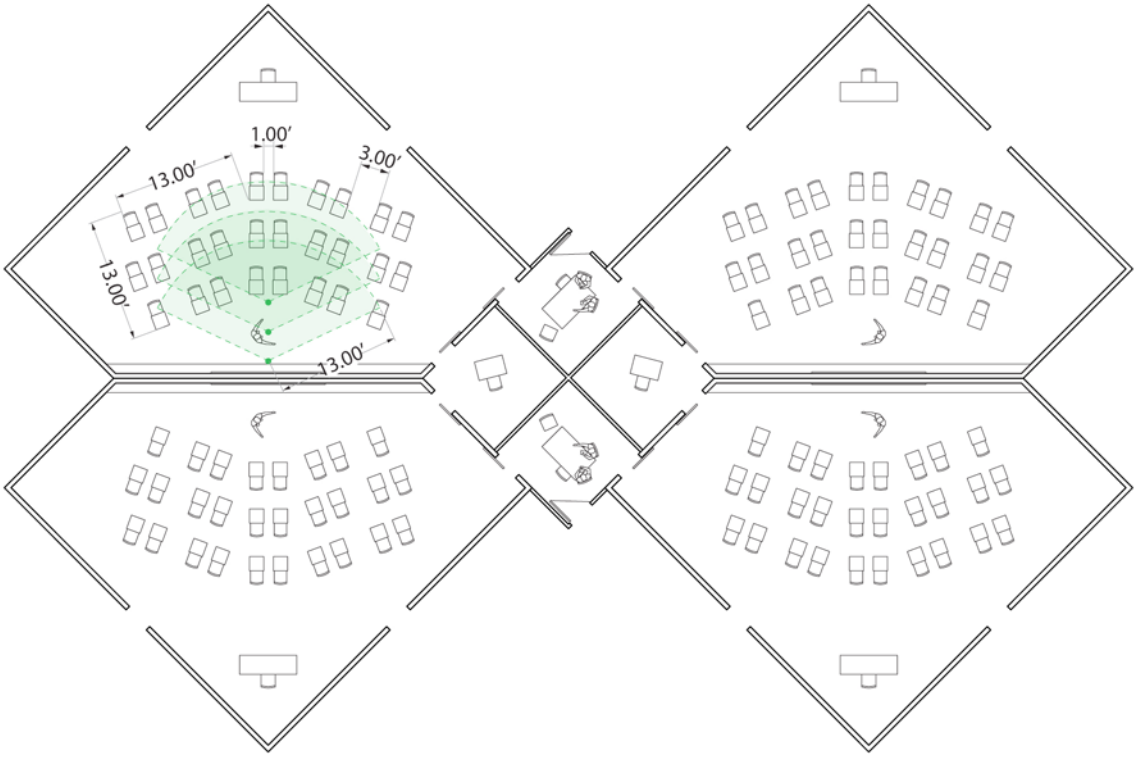

Figure 80 Classroom and small learning units.

The classroom layout was then investigated further. Per the research on proxemics, it was important that the students be within approximately thirteen feet of the teacher in order to keep them in social rather than public space, and to maintain an exchange more conversational and less like a performance (Lawson, 2001). This is also a priority of the small learning communities where increased personalization and the development of relationships is encouraged (USDOE, 2011), which is difficult to achieve when students become members of the audience rather than personally engaged in the lesson. The desirable

proxemics was a challenge given the number of students each class was required to accommodate (see figure 81).

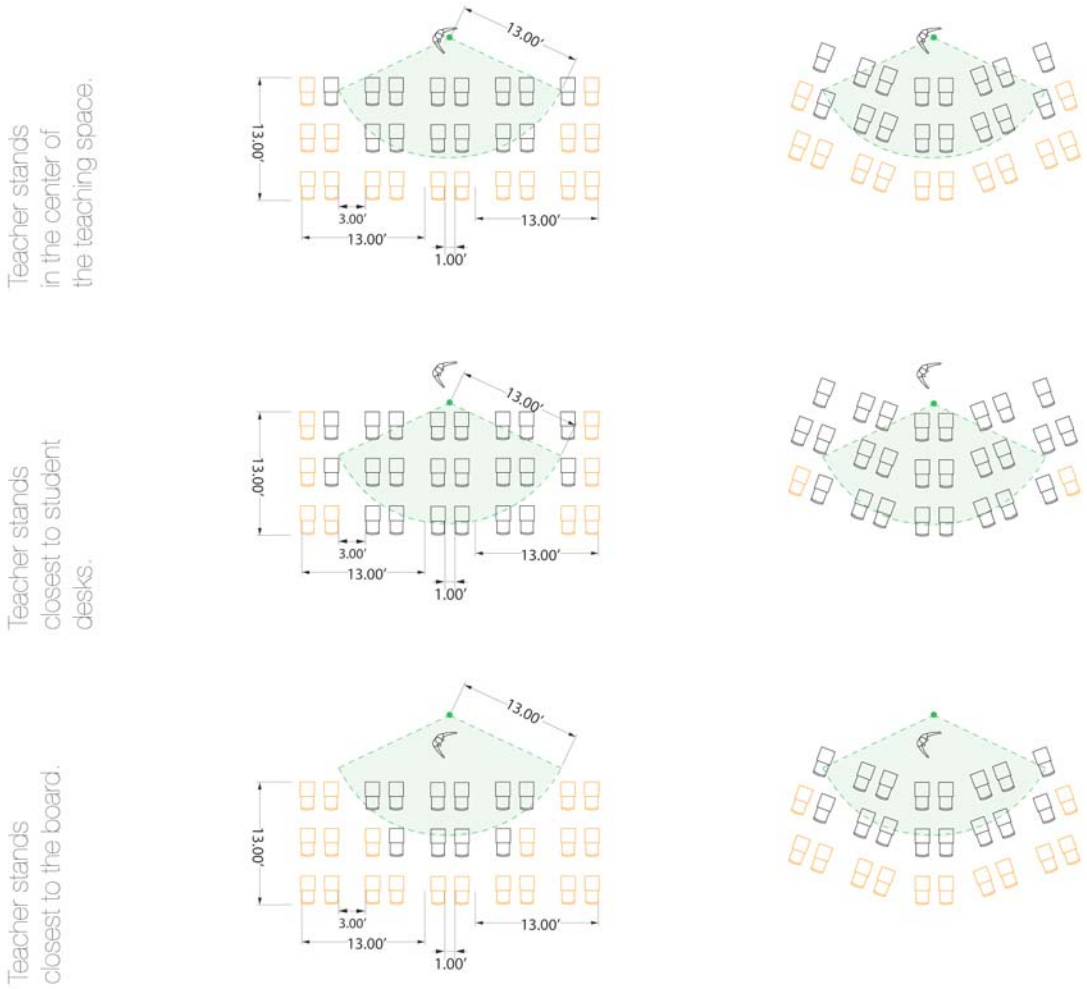

Figure 81 Demonstration of the number of students who are in the social (desks shown in black) versus public (desks shown in orange) space as the teacher moves through the teaching area.

In addition to placing the students closer to one another and the teacher, it was important to make conversation more viable while maintaining a student's ability to follow a lesson at the board. The angle

of the desks allows students to be attentive to the board and teacher while placing them in more sociopetal conditions. Shoulder to shoulder, the standard seating format, is demonstrated to be an unfavorable orientation for conversation (Brebner, 1982). The gentle twenty-degree angle (see figure 82) should allow students to see and engage with one another.

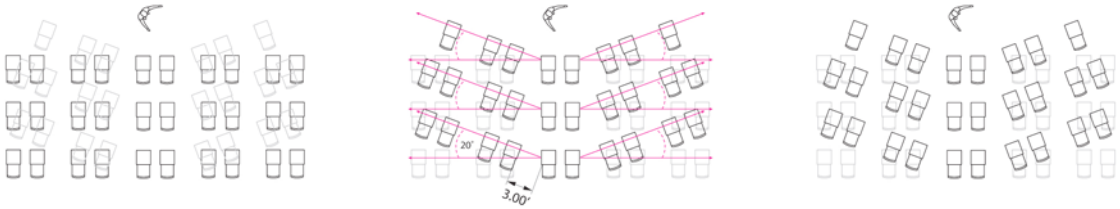

Figure 82 Angling the students towards one another allows for conversation and lecture.

7.2 SITE ORGANIZATION

At the scale of site organization, there were several operating assumptions. The first prioritized the provision of natural light and ventilation in each of the classrooms. Therefore, a courtyard was associated with every class.

The second, in the spirit of small learning communities, prioritized the creation of many discrete spaces over large singular experiences.

The third was the necessity for the school to operate as three separate high schools, while also sharing many facilities such as the cafeteria, media center, and elective classrooms.

Lastly, it was important to incorporate the community into the design. Spaces that might be utilized by the community after hours or on the weekends were located in places where they could be accessible while the majority of the building remained secured.

7.2.1 The Addition of Courtyards

The desirability of natural light and ventilation in classrooms is heavily supported in research. Students showed greater preference for, higher learning outcomes in, and stronger attendance at schools with natural light and ventilation in one study in England (Edwards, 2006). In Harry Wohlfarth's 1983 study (cited in Mahnke, 1996) students performed better in natural light than artificial light on intellectual assessments as well as measures of stress.

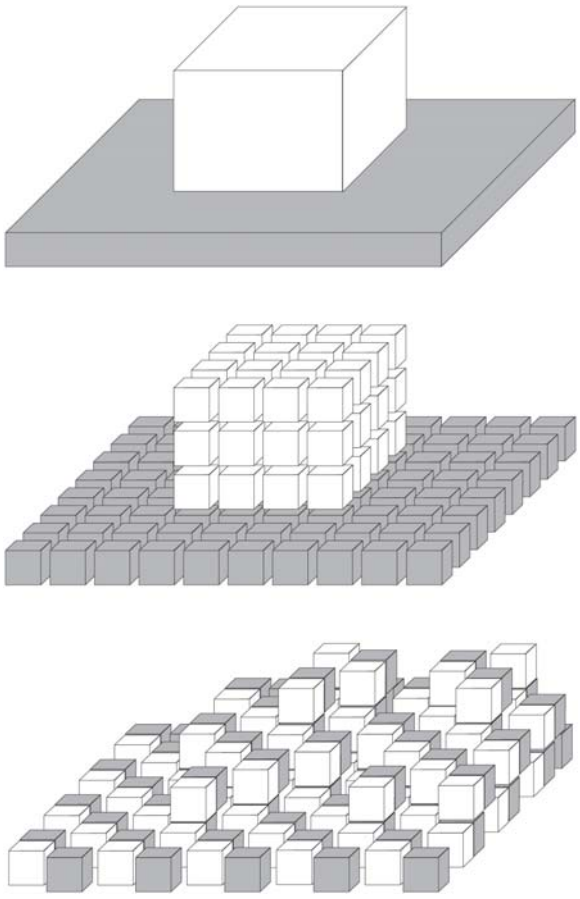

Figure 83 Diagram demonstrating the concept of incorporating the site into the building program.

Daylight and views to the outside have long been associated with preferential conditions. A ‘corner office’, characterized by multiple windows, and a ‘room with a view’ are clichés because of their near-universal acceptance as desirable. Therefore, the incorporation of natural light and ventilation, as well as the ability to learn or relax in an outdoor environment help to create a more desirable and varied classroom experience. Both by its nature and its associations (Helmers,

2004) the addition of courtyards contributes to the “warm, supportive, non-threatening” and non-institutional space being designed (Laroque, 2008).

The courtyards were designed to be large enough for one or two classes to work outside at a time. Since they are shared spaces, it was important to privatize a small portion of the yard. The inward reaching angles of the corridor and small group workspace create an implied boundary around private outdoor space for each classroom.

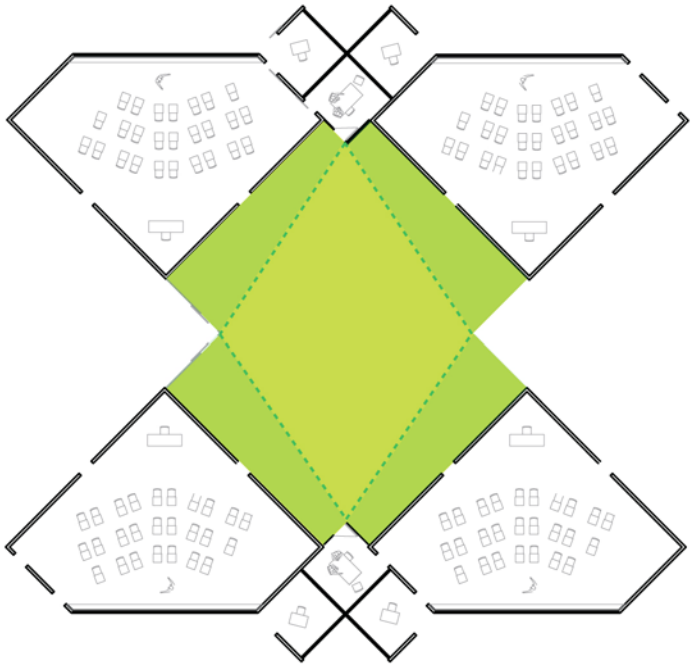

Figure 84 Diagram highlighting portions of the courtyard, which through implied boundaries become more privatized to the classrooms.

7.2.2 The Creation of Discrete Spaces

The desire for the school to be comprised of a series of discrete spaces rather than conceived as one large space is in keeping with the idea of small learning communities. Students can seek out individual spaces; once they enter discrete spaces, they are separated physically and visually from other students milling about. This allows students to connect with smaller groups at any given time, and to perceive themselves as having greater influence and belonging not only because they choose to be in one space versus another, but also because the scale of the space is more relatable to the student. This may also help to relieve crowding, or rather the effects of crowding, which is found to be negatively associated with the development of relationships and positively associated with increased tension between people (Baum 1978 cited in Brebner, 1982; Baldassare 1978 cited in Brebner, 1982).

A student's ability to escape crowding is key to avoiding the adverse effects associated with it (Rodin 1976 cited in Brebner, 1982). The 'inlets' in the corridors allow students to temporarily step out of the main flow of circulation to gather with friends or organize belongings. Additionally, the courtyards provide secondary circulation routes that give a literal breath of fresh air while avoiding the main circulation path.

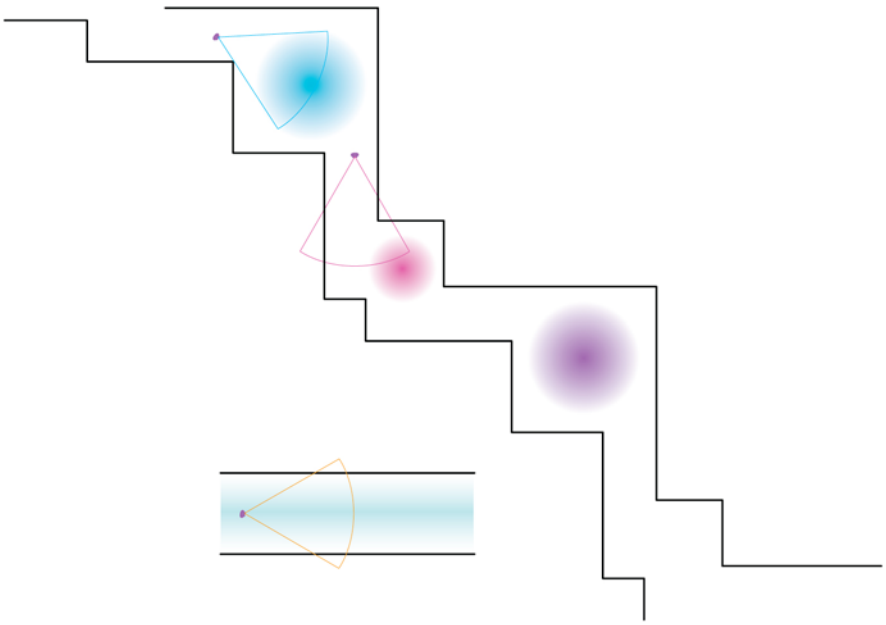

Figure 85 Diagram of how the angled corridor creates discrete spaces versus the singular experience offered by a straight corridor.

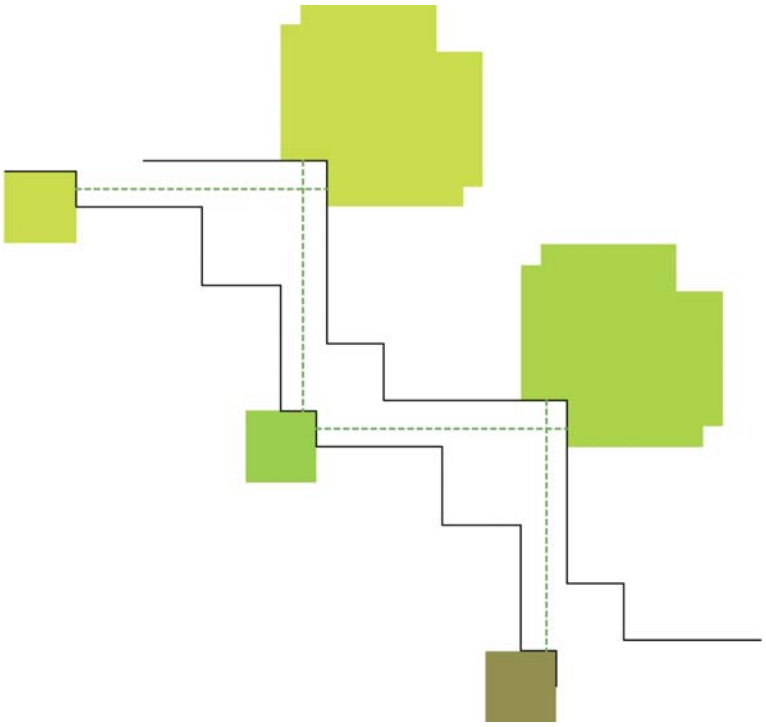

Figure 86 Despite the division of the hallway into discrete spaces, courtyards are always placed on axis allowing the student the sensation of walking from open space to open space.

Figure 87 The corridor angles control views but still provide efficient space for nearly straight-path circulation; they also allow space for gathering.

The logic of creating discrete spaces was followed throughout the school design. For example, in the cafeteria, seating is arranged around

a larger courtyard, thus effectively dividing the whole group, although they can easily connect with one another since the spaces are adjacent. Similarly, in the media center, there are private and public group spaces as well as individual study spaces, which allow students the ability to vary their experiences. Finally, the courtyards are also varied according to their location and the size and purpose of the yard: the smallest, primarily for viewing; the middle-sized classroom courtyard designed for outdoor learning; and the largest courtyard, which accommodates the entire student body.

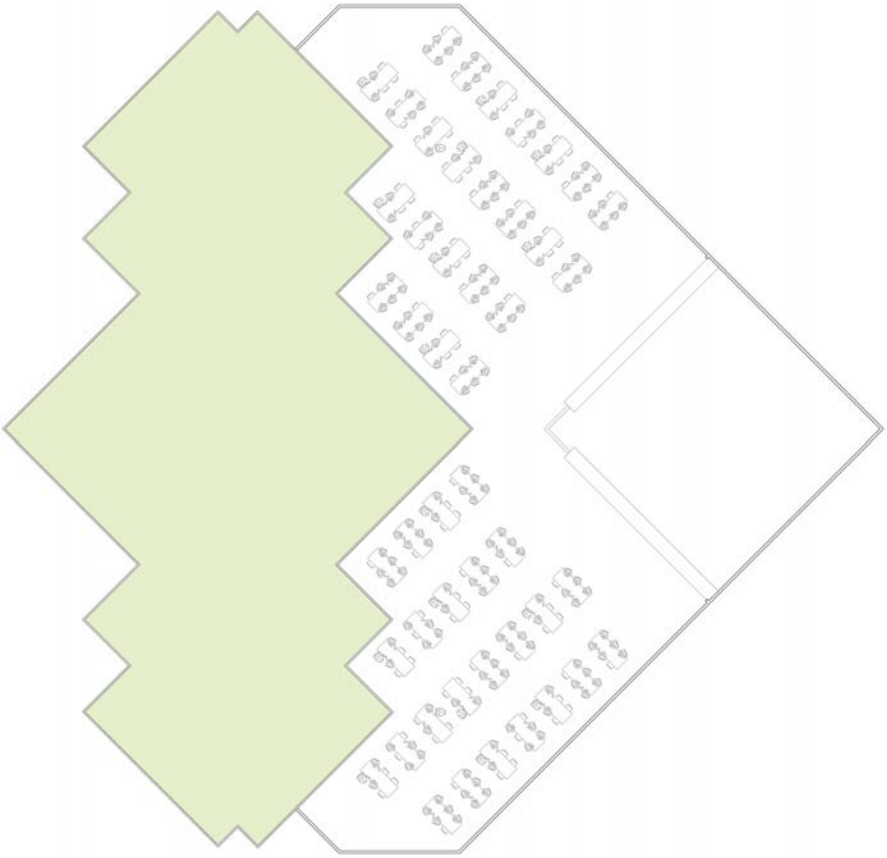

Figure 88 Cafeteria in plan.

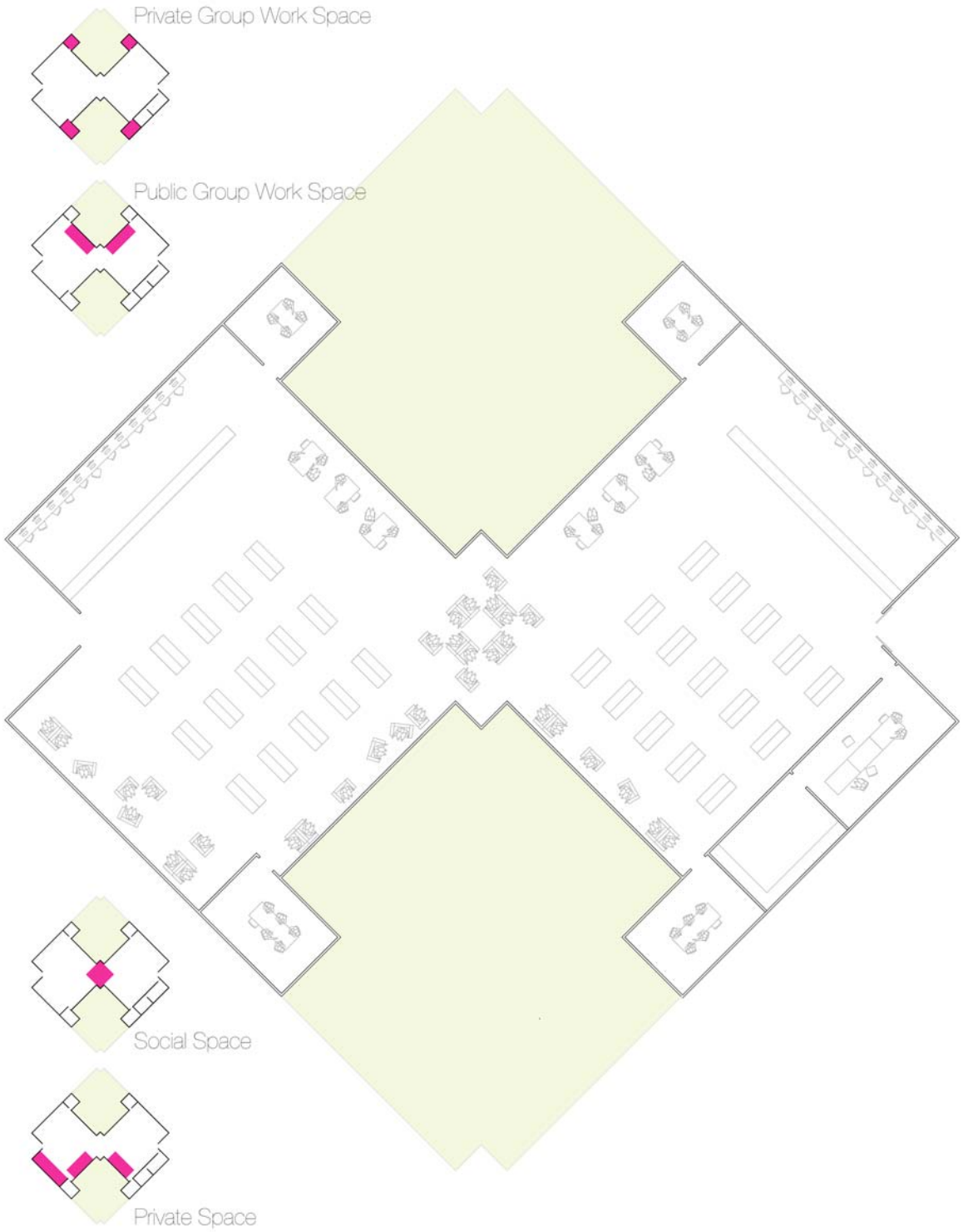

Figure 89 Media Center in plan.

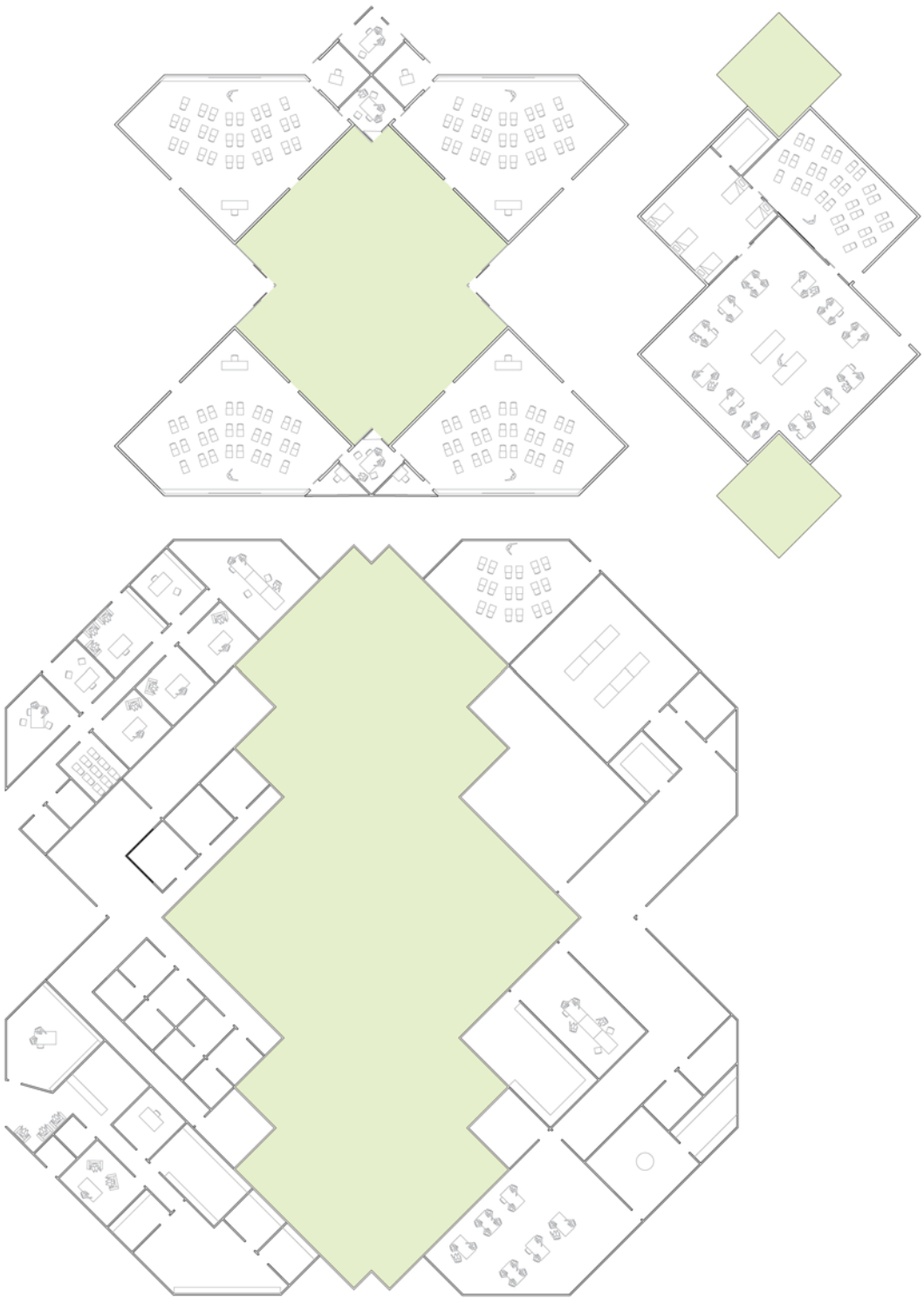

Figure 90 Different size courtyards.

7.2.3 Three High Schools in One

Although the students in Therrell will be divided into three separate groups, they will still share many of the same facilities. The building must effectively function as a single traditional high school, but must also support the small learning community initiative.

Students are primarily separated into their learning academies. However, there are visual connections between the academies through courtyards and also through thematic classrooms. Students will mix several times a day in the shared spaces, which are heavily supervised by the individual administrations that are situated throughout the hallway.

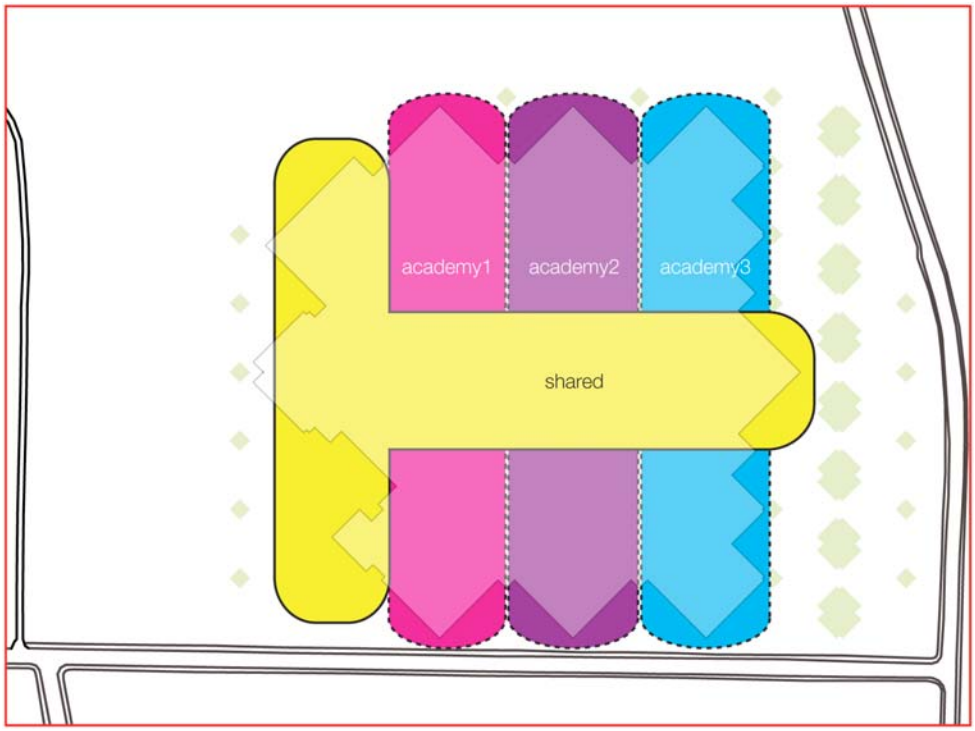

Figure 91 Diagram showing how the school is organized.

7.2.4 Involving the Community

In the spirit of small learning communities, it was important to create a more accessible school building that could bolster the community as a whole and support students and their families outside of the standard school day, thus broadening the impact of the school system.

The theater, media center, and athletic facilities are adjacent to the parking area, and thus easily accessible. Each has the potential for exterior access and can be secured independent of the academies. There are also gardens and walkways on the roof of the school allowing for community gardening, exercise, and other outdoor activities.

Figure 92 Community elements highlighted on the site plan.

CHAPTER 8
DESIGN DEVELOPMENT

8.1 THE CLASSROOM

When considering the design for the interior environments, the primary consideration was for a warm space. Wood was a natural choice for the primary structure. So as not to dampen the effects of natural light, the exposed wood is intended to be as light as possible, either by utilizing a blonde variety such as maple or birch or by a secondary application of whitewash. The effective color will be neutral: white with a gentle yellow cast. Leatrice Eiseman, in her book *Color: Messages and Meanings* (2006) characterizes colors in the ivory or cream family as "neutral, soft, warm, comforting, natural"(53). She writes, "This 'colorless color' may lack the excitement of red or orange, yet its inherent warmth and subtlety does have a comforting, nurturing presence"(53).

This warm understated tone will not only reflect the natural daylight, but will also balance with the complexity of the structural pattern that will be visible. As both Brebner (1982) and Mahnke (1996) highlight, it is the balance between singularity and variety that is important in design. While the color is subdued, the pattern and texture of the material add variety.

The flooring in the classrooms is carpet for noise reduction, and also to warm the space. The addition of texture and color anchor the room and connect with images of more personal environments such as home.

The colors chosen for the design iteration represented in the rendering below (see figure 93) include a mix of warm and cool colors in a pattern consistent with the structure above.

Figure 93 Rendering of classroom interior.

8.2 The Exterior

It was important that the site and building be considered together. The building, which appears large in plan, seems much smaller to the visitor in experience. The building is nestled into the ground at the southeast corner, increasing in visibility to the west as the topography falls away. The western side of the building is entirely above ground exposing the entrance and public program elements including the media center, theater, and gymnasium.

Allowing the topography to meet the building at roof level on the southeast corner allows visitors or students to access the gardens and walkways that stretch over the school itself (see figure 94).

Figure 94 Rendering of building exterior.

The school becomes part of the landscape, and the landscape continues to register the pattern of the school by the development of gardens in place of courtyards across unbuilt portions of the site.

The development of accessible gardens across the roof helps to retain an open and natural feeling adding to the warm and welcoming nature of the school.

CONCLUSION

The bodies of research related to the design issues are quite wide, and narrowing the field of focus was a difficult task. It was easy to be convinced of the importance of design early on: of its impact upon the user physiologically and psychologically. However, few studies offered any concrete recommendations for the designer to carry into practice. In the absence of research or application of research to design, a designer's awareness of the impact of decisions may usefully regulate impulsivity, but otherwise leaves him or her helpless: aware of responsibility, but ill-equipped to take appropriate action.

Much of the relevant research on environmental impacts on behavior, cognition, and well-being dates from the 1950's to the early 1980's and has been the result of tremendous inter-disciplinary efforts. Few of these studies have been pursued by researchers within the field of architecture, however, and even fewer are published in journals specific to architectural practice. Post-Occupancy Evaluation is the exception to this, but it deals primarily with the use of space rather than it's effects on the user.

Further research must be undertaken by architects to understand how users perceive the space around them. Only with a thorough understanding of how the user is receiving the messages embedded in

the built environment can the designer more effectively plan for the communication of his or her ideas through architecture.

APPENDIX

Project Reference Materials

#	Space	Sq Footage (per space)
	CLASSROOMS	
41	Typ Multipurpose Classrooms	750
17	Language Arts	
13	Mathematics	
1	Math Lab	
13	Social Sciences	
8	Foreign Language Classrooms	
2	ESOL	
1	Foreign Language Lab	
1	Hearing Impaired (w/add mech + office)	750
1	ISS Classroom	750
	SCIENCE	
12	Science Labs	1000
4	Biology Labs	
2	Chemistry Labs	
1	Physics Lab	
5	Science Prep/Stock Rms (shared between 2 labs)	260 each
1	Additional Mechanical Space	
	HEALTH OCCUPATIONS	
1	Main Space (seats 28)	840
1	Classroom (seats 25)	750
1	Teacher Work Room	400
1	Office	140
1	Restroom Men	50
1	Restroom Women	50
1	Kitchen	Comply with GDOE rqrmnts
1	Patient Beds (x3)	
	Exam/sick room	100 each
1	Additional Mechanical Space	
	CULINARY ARTS	
1	Kitchen (for industrial kitchen equip)	1500
1	Pantry	200
1	Linen	150
1	Prep Space	(part of kitchen)
2	Offices	150 each
	BIOTECHNOLOGY	
1	Main Space (for 46; central demo table, counter/sinks)	1000
3	Computer Workstations	140
	PUBLIC SAFETY	
	Main Space (seating for 37)	1110
	Jury Box (seating for 12)	170
	Judges Stand	30

	Witness Stand	30
	Classroom for 25	750
	Office	150
	Storage	250
	Teacher Work Space	400
	FINE ARTS	
1	Main Space for art work stations	1000
1	Kiln Room	350
1	Supply Room	250
1	Office	150
1	Storage	250
2	Restrooms Men	60
2	Restrooms Women	60
1	Teacher Work Area	150
1	Spray Booth	100
1	Photo Lab (dark room)	750
1	Chemical Storage	100
1	Multi-Purpose Classroom/Film Processing	750
2	Flm Loading	50
1	Gallery	500
	STUDIOS	
2	Multi Purpose Studios	1000
1	Office	150
1	Storage	250
	ENGINEERING	
1	Main Space (seating for 24)	1000
1	Computer Workstations (x25)	1200
1	Lecture Classroom (seating for 25)	750
1	Robotics Lab	1000
1	Tool Storage	250
1	Additional Storage	
1	Office	150
1	Teacher Work Space	150
1	Additional Mechanical Space	
	TECHNOLOGY ENERGY LAB	
1	Main Space (seating for 28)	840
1	Computer Workstations (x25)	1200
2	Offices	150 each
1	Storage	250
	THEATER	
1	Theater (seating for 300)	
1	Audience Seating	3000
1	Stage	800
1	Control Room	100

1	Ticket Booth	200
1	Stage Shop/Storage	800
1	Costume Room	150
1	Dressing Rooms Men	100
1	Dressing Rooms Women	100
1	Additional Mechanical Space	
1	Dance Room	750
	ADMIN	
3	Principal Office	200-350 each
3	Graduation Coach Office	120 each
3	Admin Office	180-200 each
3	Connselor Office	150 Each
3	Misc. Office	
1	Waiing Area	400
1	Receiptionist	150
3	Secreterial Workspaces	120 each
1	Registrar's Office	180
1	Records Storage/Storage/Supplies	300
1	General Storage/Supply Room	200
2	Conference Rooms	400
2	Staff Restrooms	40 each
2	Public Restrooms	60 each
1	Parent Center	750 each
1	In School Suspension Room	120
1	Vault Room	75
1	Archives	based on school need
1	Records Storage	130
	RESTROOMS	
1 per floor	Public Men and Women (8)	60 each
1 per floor	Admin/Educator Men and Women (2)	40 each
	MEDIA CENTER	
1	Main Room	2000
	x36 10' book shelves	
	x5 tables for 4	
	x2 tables for 6	
	x12 double tables for individual work	
	x10 soft seats	
	x24 work stations	
1	Computer Classroom	1200
1	Work Room	240
1	Restroom Men	60
1	Restroom Women	60
2	Group Work Rooms	120
1	Circulation Desk	200
1	Office	150
1	Storage	170

	BAND ROOM	
1	Main Room (to seat 60)	2000
1	Equipment Storage	300
1	Uniform Storage	300
1	Office	150
2	Practice Rooms	80
1	Choral Room	2000
1	Orchestra Room	2000
1	General Classroom	750
1	Music Storage	250
	GYM	
1	Main Gym (seating for 500)	8000
1	Practice Gym	5000
1	Weight Room	1000
1	Locker Rooms (M+W, Home+Visitors)	2000 each
1	Team Storage	250
1	General Storage	750
6	Offices	150
1	Trainer	200
1	Laundry	150
2	Health Classrooms	750 each
1	Restrooms Men (8)	60 each
1	Restroms Women (8)	60 each
1	Tickets/Box Office	200
1	Concessions/Spirit Store	300
1	Athletic Director Office/Shower/Toilet	230
1	P.E. Coaches' Office/Shower/Toilet	350 each
1	Visiting Team Room	500
1	Staff/Coach Showers	250
1	Vending	100
	HEALTH CLINIC	
1	Main Clinic	140
2	Exam Rooms	100 each
2	Offices	150
1	Restrooms Men	50
1	Restrooms Women	50
	DINING HALL	
1	Main Space (seating for 330)	4000
1	Kitchen	2500-3000
1	Office	150
1	Storage	200
1	Pantry	200
	Additional Mechanical Space	
1	Food Court Servery Stations	1000

	Parent Center	750
	Career Center	120 each
	General Meeting Room	400 each
	School Store	300
	Lobby	400
	FACILITY SUPPORT	
1	Building Mechanical Office	150
6	Custodial Closets	35
2	Custodial Storage	300
	PROGRAM FOR EXCEPTIONAL CHILDREN	
3	Itinerant Teacher Classrooms	750
3	PEC Classrooms	750
	Other Electrical/Mechanical Reqrmts see Guide	
40	family unit	500
12	family courtyards	1200

Figure 95 Building program.

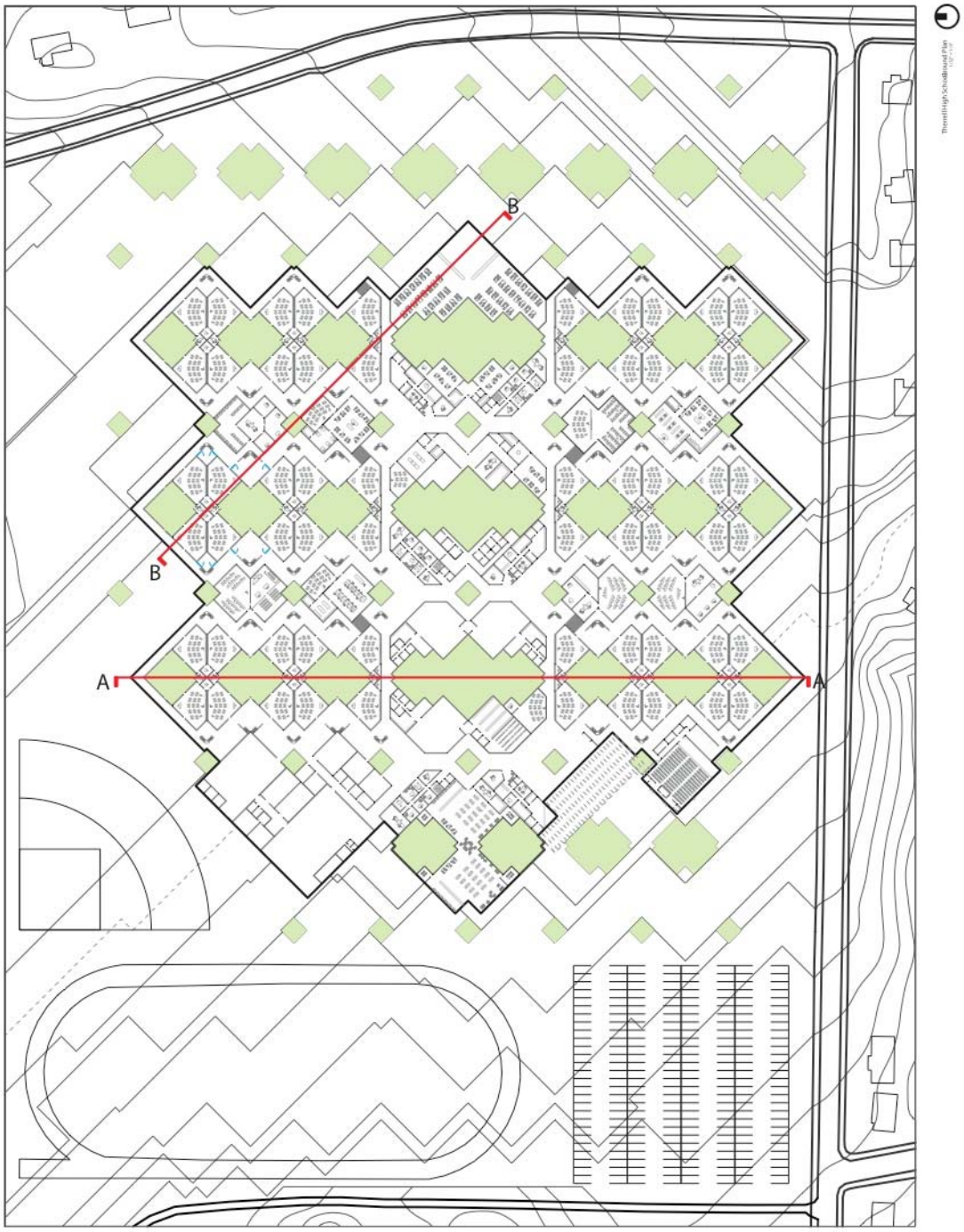

Figure 96 Building plan.

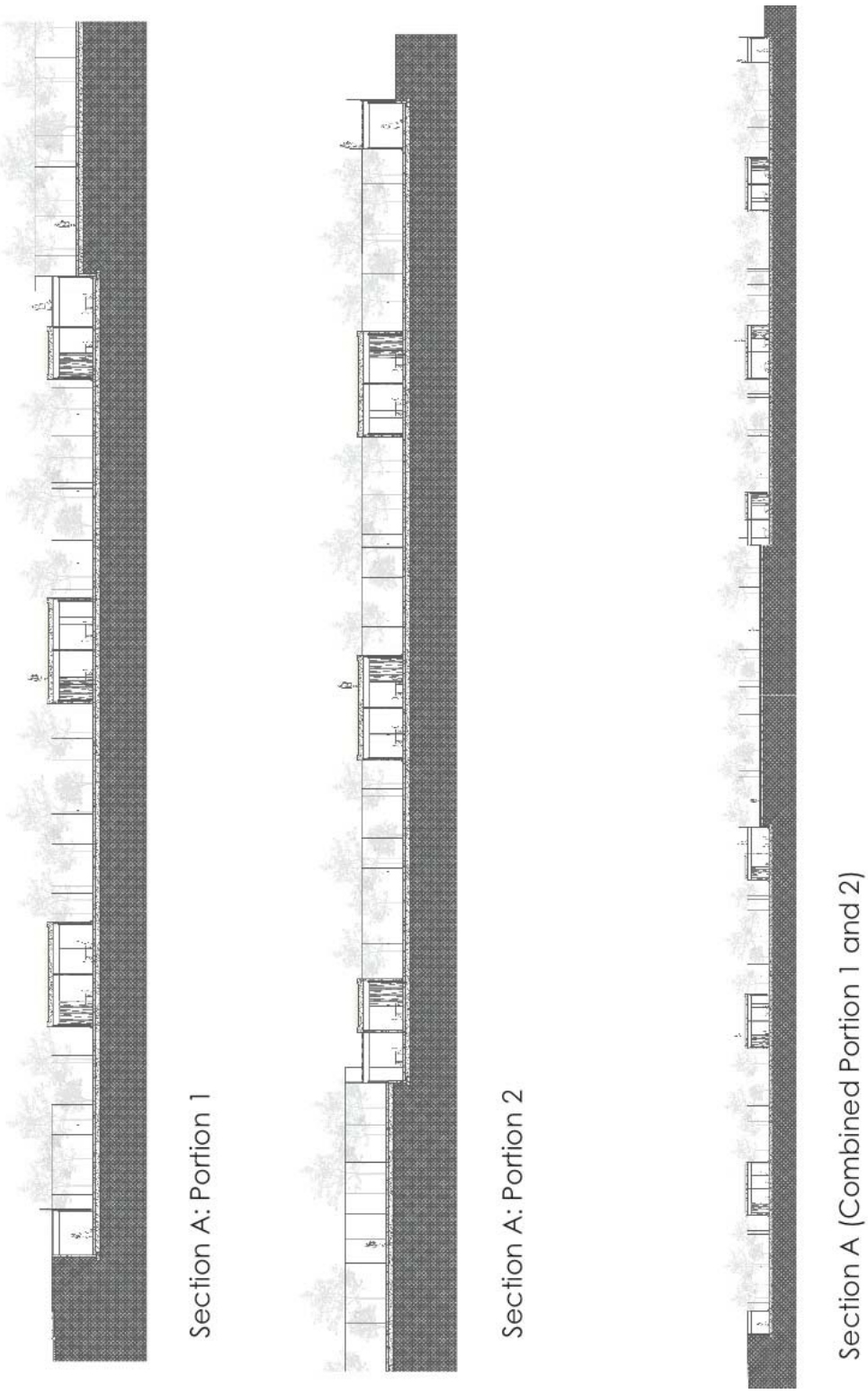

Figure 97 Section A.

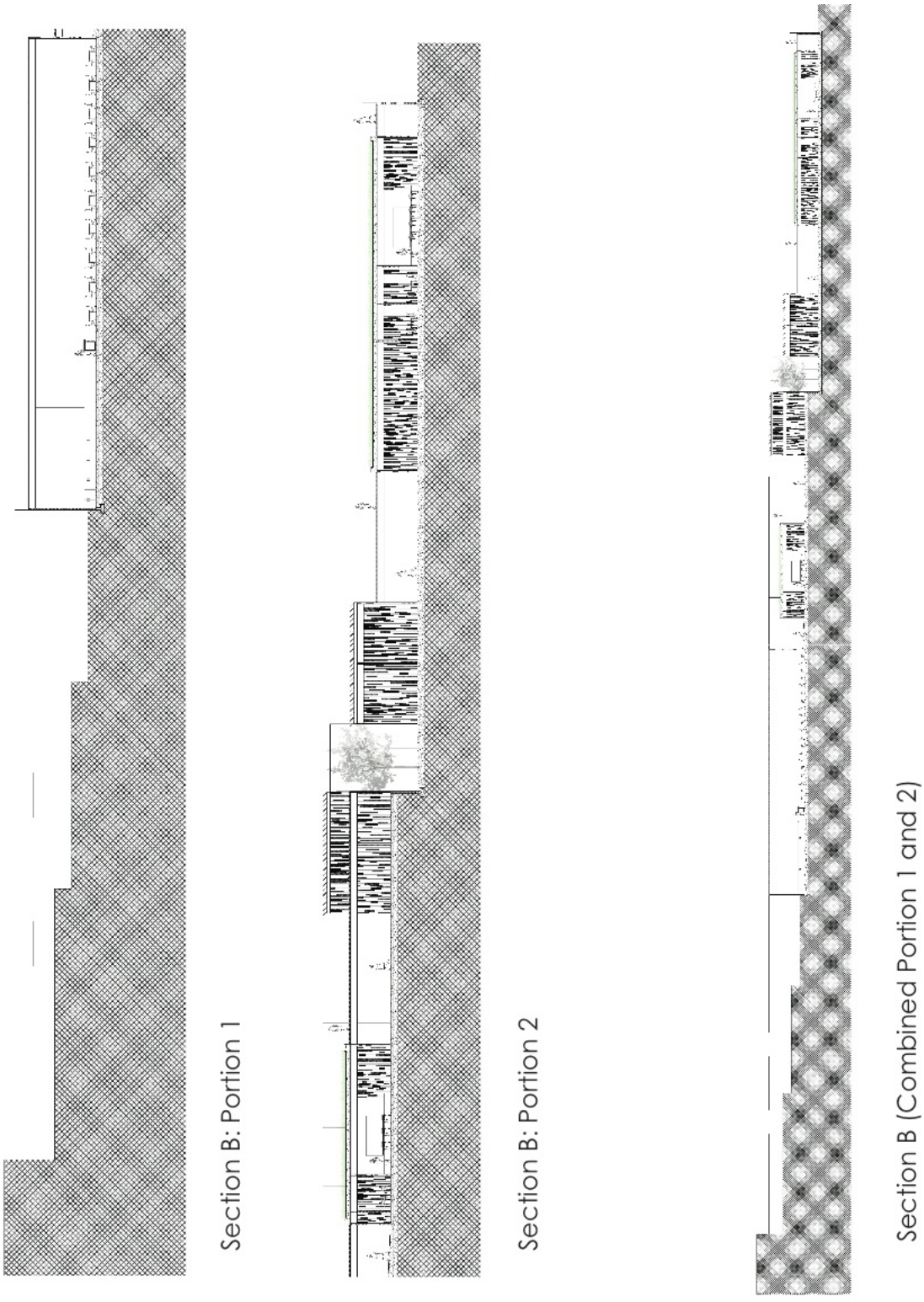

Figure 98 Section B.

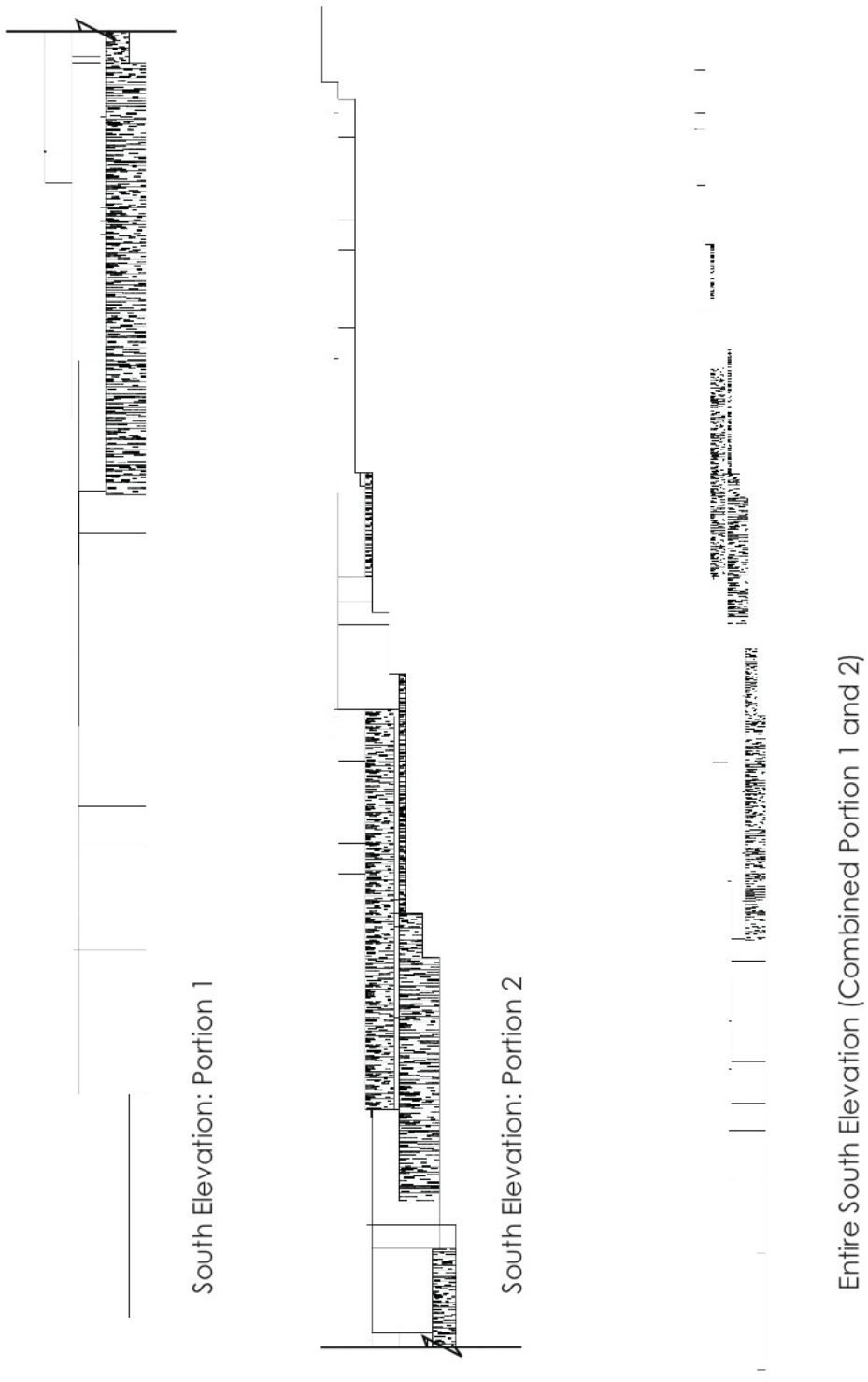

Figure 99 South Elevation.

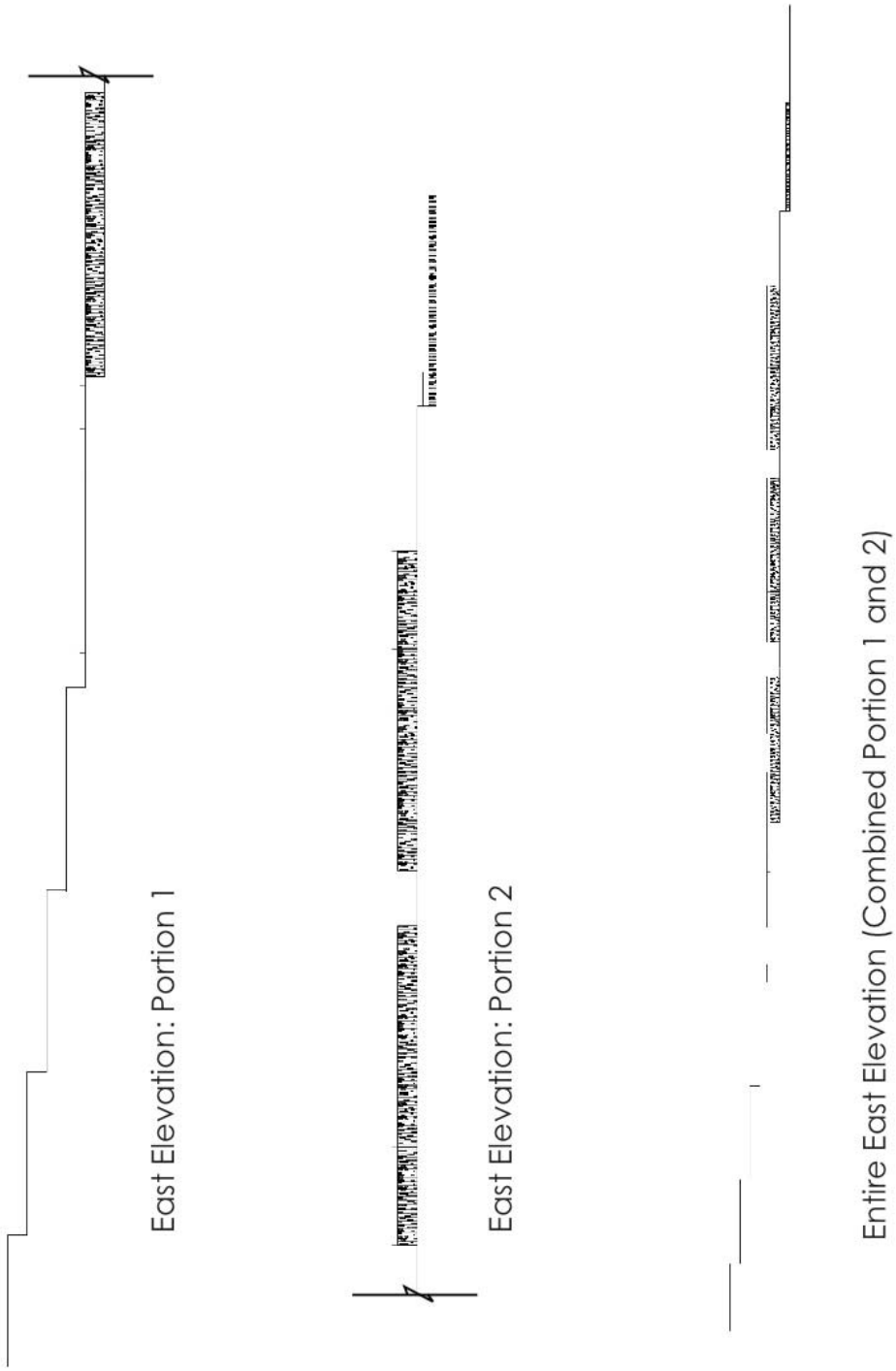

Figure 100 East elevation.

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